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# General Vehicle Electrical II

**Model: E90**

**Production: From Start of Production**

# OBJECTIVES

After completion of this module you will be able to:

- Explain distributed functions
- Diagnose the various electrical systems
- Discuss the operational signal paths of the various systems
- Identify the key control modules for each system

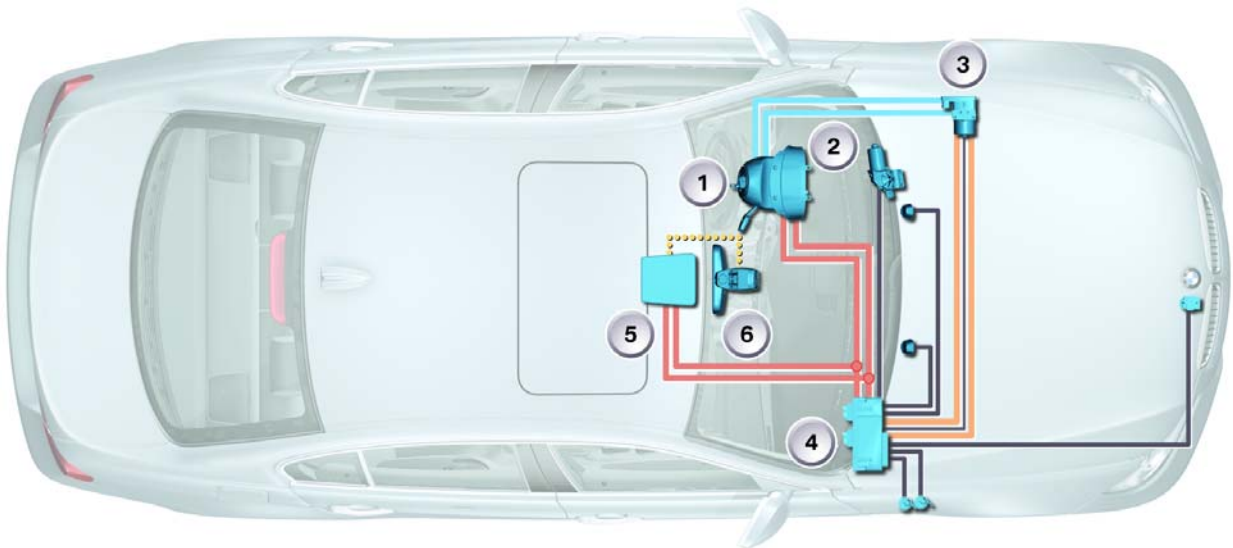
# Wiper/Washer System

The wipe/wash system on the E90 is a conventional wipe/wash system. This means that the wiper motor is equipped with a return contact.

## System Components

The following components are involved in the wipe/wash system:

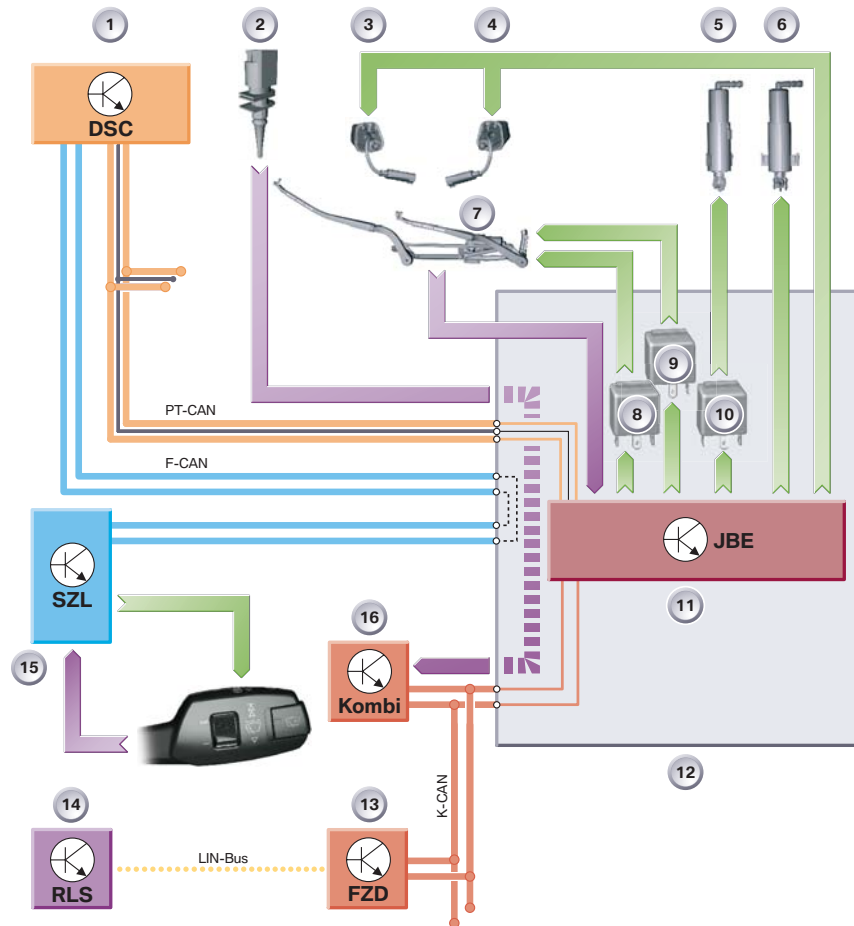
- Wiper motor with return contact
- Pump for headlight washer system
- Control units:
  - Steering column switch cluster (SZL)
  - Junction box control module (JBE)
  - Instrument cluster (IKE/Kombi)
  - Dynamic stability control (DSC)
  - Roof function center (FZD)
  - Rain and driving lights sensor (RLS)
- Washer fluid pump
- Heated water jets.
- Relays:
  - Relays 1 and 2 for wiper motor
  - Relay for headlight washer system



### System Components - Wipe/Wash System

Index	Explanation	Index	Explanation
1	Steering Column switch cluster	4	Junction box control module
2	Instrument cluster	5	Roof function center
3	Dynamic stability control	6	Rain and driving lights sensor

## Wiper/Washer System - Input/Output



Index	Explanation	Index	Explanation
1	Dynamic Stability Control (DSC)	12	Junction Box (JB)
2	Outside temperature sensor	13	Roof Functions Center (FZD)
3	Heated water jet, driver's side	14	Rain and Driving Lights Sensor (RLS)
4	Heated water jet, front passenger's side	15	Steering Column Switch Cluster (SZL) with wiper steering column stalk
5	Motor, headlight washer	16	Instrument Cluster
6	Motor, washer fluid pump, front	KL30	Terminal 30
7	Wiper motor	F-CAN	Chassis CAN
8	Relay 1 front wiper motor	K-CAN	Body CAN
9	Relay 2 (soldered) front wiper motor	PT-CAN	Powertrain CAN
10	Relay, headlight washer system (SRA)	LIN-bus	LIN-Bus
11	Junction Box Electronics Control Module (JBE)	RSK	Reset contact



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## Control Units

### ■ Junction Box Electronics Control Module (JBE)

The Junction Box Electronics Control Module is the master for all wiper functions.

The relays for the wipe/wash functions are installed in the JBE. The relay for the continuous wipe function in Stage 1 is plugged in and the relay for Stage 2 soldered to the PC board.

A relay is installed in the Junction Box for the headlight washer system.

### ■ Roof Functions Center (FZD)

The Rain and Driving Lights Sensor is connected via LIN-Bus to the Roof Functions Center.

### ■ Dynamic Stability Control (DSC)

The Dynamic Stability Control makes available the vehicle speed signal and is the interface to the Steering Column Switch Cluster (SZL).

### ■ Wiper Switch

The wiper switch with the following functions is located in the steering column switch cluster:

- Intermittent wipe
- Stage 1 and Stage 2
- Windscreen washer
- Switch for rain and driving lights sensor
- Indicator for active rain and driving lights sensor

The wiper switch is an optical switch. The functions of the optical switch are described in the section entitled "Steering column switch cluster" later in this section.

The interval switch is a four-stage switch.

Each switch stage produces different input values in the steering column switch cluster SZL. The input values are evaluated, for example, for setting the sensitivity of the rain and driving lights sensor.

The button for the rain and driving lights sensor is designed as a ground-switching button. It is required to switch on the rain and driving lights sensor. The LED on the stalk switch is illuminated when the rain and driving lights sensor is activated.

### ■ Wiper Motor

The wiper motor is designed for two speed stages and has a reset contact.

### ■ Pump for Windscreen Washer

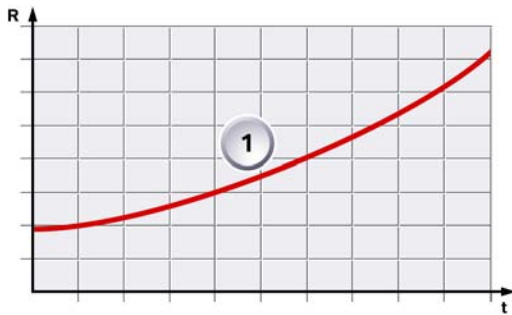
The washer fluid pumps for washing the windscreen are mounted on the washer fluid reservoir. The pump is activated directly by the Junction Box Electronics Control Module.

### ■ Pump for Headlight Washer

A high pressure pump is used for the headlight washer system. The pump is activated by means of a relay in the junction box.

### ■ Heated Water Jets

Two heated water jets are used for the windscreen washer. The water jets feature a PTC resistor that limits the current intake itself.



Index	Explanation
1	PTC resistor characteristic
R	Resistance
t	Temperature

**Example of the Characteristic Curve of the PTC Resistor**

## Service Information

### Wipe/Wash System Emergency Operating Functions

#### ■ Steering Column Switch Cluster Failing

The JBE recognizes failure of the steering column switch cluster by the absence of the "wipe switch operation" signal via the K-CAN. The JBE then switches over to emergency operating mode.

Emergency operation consists of permanent wiper operation in stage 1. The wiper operates constantly as from terminal R. It cannot be switched off until the fault has been rectified. If the steering column switch cluster SZL fails during wiper mode, the wiper will continue to operate for 11 s in the set wiper mode and then switches over to emergency operating mode.

After emergency operating mode, the wiper is updated only after receiving a new message from the SZL and determining the wiper position via the reset contact.

#### ■ Rain and Lights Sensor Failing

If the rain/driving lights sensor fails or is defective, the JBE undertakes the wiper control and switches to emergency operating mode. This emergency operating mode is an intermittent wipe mode dependent on the vehicle speed.

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## Principles of Operation

The wipe/wash system is switched on and off with the wiper switch. The wiper switch is an integral part of the steering column switch cluster (SZL).

### Wiper Switch

The following functions are switched on with the wiper switch:

- Automatic wipe with rain and lights sensor
- Continuous wipe, Stage 1
- Continuous wipe, Stage 2
- Single wipe
- Wash windscreen.

The signals of the wipe switch are sent from the steering column switch cluster via the F-CAN to the dynamic stability control. The signal is then transferred from the dynamic stability control via the PT-CAN to the Junction Box Electronics Control Module. The Junction Box Electronics Control Module evaluates the signals and activates the wiper motor.

### Windscreen Wipe Function

The following functions are available for wiping the windscreen:

- Intermittent wipe in stages
- Automatic Intermittent wipe
- Continuous wipe, Stage 1
- Continuous wipe, Stage 2
- Single wipe.

#### ■ Intermittent Wipe

The Intermittent wipe in stages only operates if the RLS system is defective. E90 will come with RLS standard. The interval can be set with the multi-stage switch. Four intermittent wipe stages are available. The time intervals depend on the set intermittent wipe stage and the vehicle speed.

The Junction Box Electronics Control Module calculates the time intervals and activates the wiper motor accordingly.

### ■ Automatic Intermittent Wipe

The automatic wipe function is activated by pressing the wiper stalk switch button at terminal R ON. When active, the "automatic wipe" function is indicated by the LED on the wiper switch. A single wipe cycle is additionally started.



Index	Explanation
1	Sensitivity adjustment wheel
2	Automatic interval switch w/LED

### Wiper Stalk Switch

The rain and lights sensor sends a wipe request corresponding to the rain intensity. The roof functions center checks the rain and lights sensor every 20 ms to establish whether the wipe request applies. When the request is sent, the rain and lights sensor confirms this request via the LIN-bus. The roof functions center sends this request on the K-CAN.

The Junction Box Electronics Control Module evaluates the request and activates the wiper motor accordingly.

During the automatic wipe cycle, the wiper wiping frequency depends on the information provided by the rain and lights sensor and to vehicle speed.

The control of the wipe/wash system is integrated in the Junction Box Electronics Control Module.

### ■ Continuous Wipe Stage 1

The wiper motor runs at normal speed when Stage 1 is switched on with the wiper switch. The wiper motor switches from continuous wipe in Stage 1 to intermittent wipe if the vehicle speed is reduced down to standstill.

The continuous wipe function in Stage 1 resumes as soon as the vehicle speed is > 4 km/h.

### ■ Continuous Wipe Stage 2

The wiper blades are moved at double the speed in continuous wipe Stage 2. When the vehicle is stationary, continuous wipe Stage 2 automatically switched back to continuous wipe Stage 1. The wiper blades then move at normal speed.

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### ■ **Single Wipe**

By pressing down the wiper switch, the flick wipe function is triggered for as long as the switch is pressed. On releasing the wiper switch, the wiper movement is completed to the park position of the wiper blades.

### **Wash Functions**

The E90 features a specific wash function for the windscreen. The function is operated via the wiper switch.

### ■ **Wash Windscreen**

On pulling the wiper switch, initially the washer fluid pump is switched on followed by the windscreen wiper. The washer fluid pump remains switched on for as long as the wiper switch is pulled.

The signal is routed from the SZL to the Junction Box Electronics Control Module (JBE).

The JBE activates the washer fluid pump directly. After the pump is switched off, the wipers continue to operate for several wipe cycles in order to wipe the windscreen dry.

The JBE will no longer drive the washer fluid pump if the fluid level in the washer fluid reservoir is too low. The JBE receives the information necessary for this purpose from the washer fluid level sensor.

### ■ **Washer Fluid Level Sensor**

The junction box monitors the washer fluid level sensor as from terminal R ON.

The Junction Box Electronics Control Module receives a low signal when the washer fluid reservoir is full. The switch opens when the fluid level in the washer fluid reservoir drops below a certain level. The low signal changes to a high signal.

The Junction Box Electronics Control Module consequently generates a message indicating the low level in the washer fluid reservoir.

### ■ **Terminal 50**

The washer function is interrupted or not at all started while the vehicle is started.

If the windscreen washer function was interrupted, the started function is continued after the vehicle start procedure has been completed.

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### ■ Headlight Washer System

The headlight washer system is switched on during the first wash cycle after terminal R ON and lights ON. Activation is then suppressed for 7 min. The headlight washer system is activated if the windscreen washer system is operated 5 times within the 7 minutes.

In response to the request from the Junction Box Electronics Control Module, the headlight washer system is switched on by means of a relay in the junction box.

The headlight washer system is no longer activated if the washer fluid level in the washer fluid reservoir is too low. The Junction Box Electronics Control Module receives the corresponding signal from the washer fluid level sensor.

The headlight washer system is not activated when blocking of the wipers is detected.

### ■ Heated Water Jets

The water jets can be heated as from terminal 15 ON. The Junction Box Electronics Control Module activates the water jet heating system via two separate outputs.

Activation is dependent on the outside temperature and whether the windscreen wipers are switched on. The Junction Box Electronics Control Module calculates the operating time of the water jets. The clock frequency for activation is 1 Hz.

Temperature	<-10	-10 to 5	5 to 10	10 to 15	15 - 20	>20
On time in % (with wipers off)	100	100	0	0	0	0
On time in % (with wipers on)	100	100	75	50	25	0



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## Classroom Exercise - Review Questions

1. What modules are involved in the operation of the wiper/washer system?

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2. In the event the RLS fails, how will the wipers operate?

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3. In the event the JBE does not receive a signal from the wiper switch, how will the wipers operate?

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# Park Distance Control

On the E90, Park Distance Control (PDC) is a distance warning system that provides both visual and audible information on the distance to the nearest obstacle when parking and driving out of spaces.

The distance to the nearest obstacle is measured by the four sensors in the rear bumper.

The distance is signalled audibly via the speakers in the rear of the vehicle. Signal tones increase as the distance to the obstacle decreases.

A permanent tone signal is output when vehicle is in close proximity to obstacles. The signal tones are produced and output by means of the existing audio system (RAD2 or CCC).

When the vehicle is equipped with navigation, the graphic distance signalling is shown on the Central Information Display (CID).

The PDC can be switched on and off by means of a button in the center console Switch Cluster (SZM).

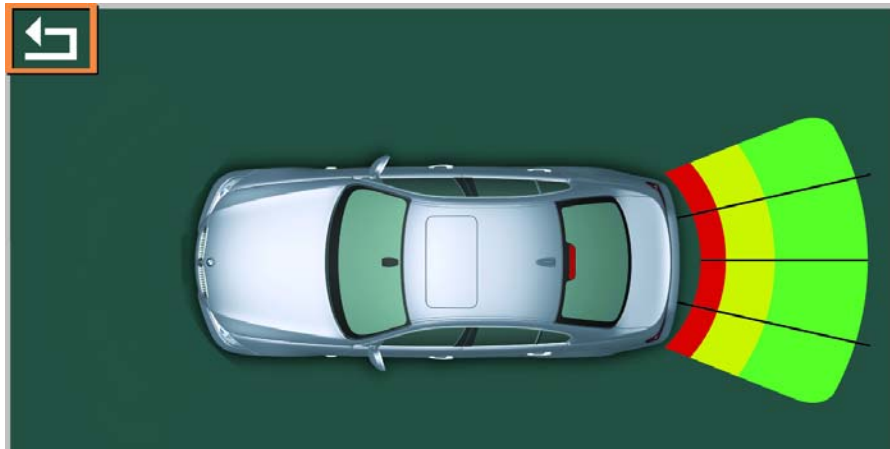
The following changes/new features have been implemented compared to the predecessor models:

- Different speaker configurations (corresponding to equipment).

## System Components

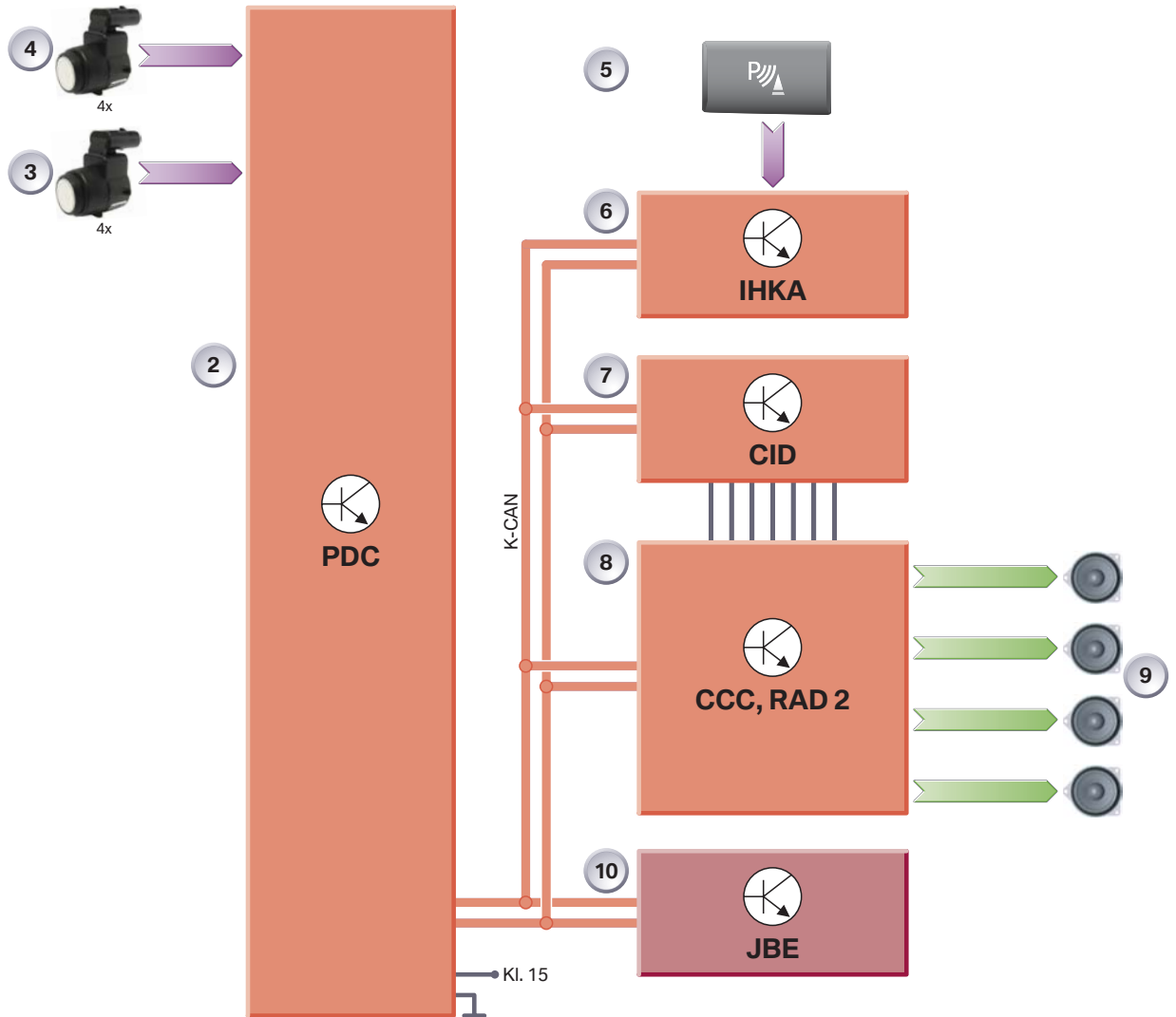
The following components are involved in the PDC system:

- PDC control unit
- Four Ultrasonic Sensors
- Audio system (RAD2 or CCC w/speakers)



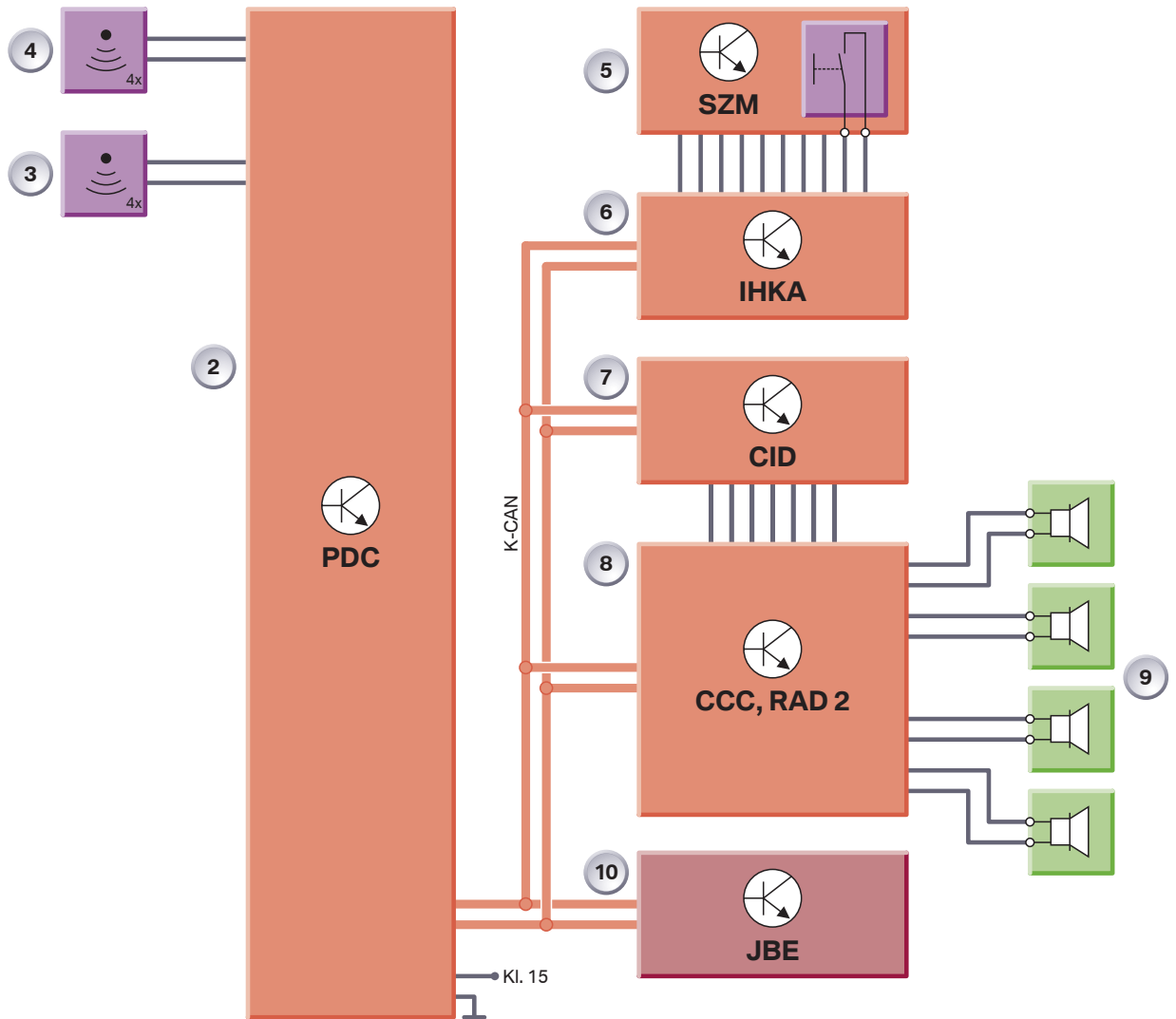


# IPO



Index	Explanation	Index	Explanation
1	N/A	6	IHKA
2	PDC Control Unit	7	CID
3	4 sensors, rear	8	RAD2 or CCC
4	not for US	9	Audio system speaker
5	PDC button on SZM	10	Junction Box Electronics Control Module

## System Circuit Diagram



Index	Explanation	Index	Explanation
1	N/A	6	IHKA
2	PDC Control Unit	7	CID
3	4 sensors, rear	8	RAD2 or CCC
4	not for US	9	Audio system speaker
5	PDC button on SZM	10	Junction Box Electronics Control Module

## Control Unit

A 4-channel (rear only) PDC control unit is installed in the E90. Activation of the audible and visual distance signalling is through the RAD2 or CCC.

The PDC control unit is installed on the rear right in the luggage compartment and for U. S. applications the control unit has two connectors.



Index	Explanation
1	Connection, vehicle harness
2	Connection, rear sensors
3	Connection, front sensors (not for US)

**PDC Control Unit**

## Ultrasonic Sensors

The sensors used on the E90 offer additional benefits:

### ■ Larger Range

The range of the new sensor is approximately 250 cm. The entire range of the sensors is used for visual distance signalling. The converter range is reduced to 150 cm at the rear for audible distance signalling.

### ■ Optimized Design

The length of the sensors in the E90 are approx. 50% of the previous sensor, which results in a reduced housing depth of the sensor. Due to the new design, the sensor is not decoupled in the component. The decoupling ring does not serve as a seal.

The installation of the decoupling ring is essential and ensures trouble-free operation.



Index	Explanation	Index	Explanation
1	Decoupling ring	3	Sensor housing
2	Outer diaphragm	4	Connector

## Principles of Operation

### Ultrasonic Sensors

The Ultrasonic Sensors operate based on the echo-sounding principle.

#### ■ Send Mode

The ultrasonic sensor behaves as a "speaker" in send mode.

By triggering electric pulses, the electronic circuitry of the ultrasonic sensor causes the piezoelectric crystal located on the inside of the outer diaphragm to move (conversion of electrical energy to mechanical energy).

The outer diaphragm vibrates in line with the resonance frequency and produces ultrasonic waves. The short pulse sequences (12 sinusoidal oscillations) hit an obstacle and are reflected.

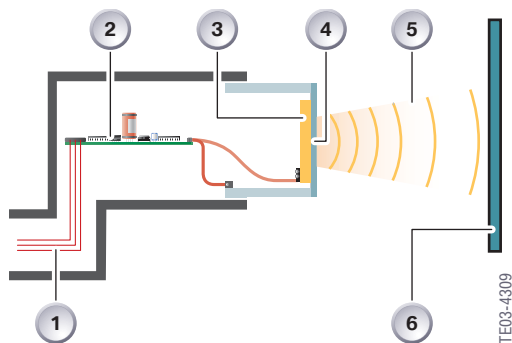
#### ■ Receive Mode

The ultrasonic sensor behaves as a "microphone" in receive mode.

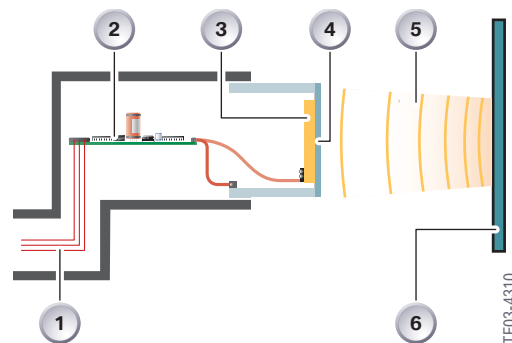
After the outer diaphragm has settled (~1 ms), the ultrasonic sensor receives the ultrasonic waves reflected by the obstacle.

The outer diaphragm and the piezoelectric crystal oscillate and send the electrical pulses to the electronic circuitry of the ultrasonic sensor (conversion of mechanical energy to electrical energy).

#### Send Mode



#### Receive Mode



Index	Explanation	Index	Explanation
1	Ultrasonic sensor connection	4	Outer diaphragm
2	Ultrasonic sensor electronics	5	Ultrasonic waves
3	Piezoelectric crystal	6	Obstacle/wall

## Control Unit

The electrically measured signal is digitized and transferred to the control unit, which processes the data to establish the distance to the obstacle is calculated.

Echo propagation time is calculated from the send start time and the time the incoming echo is received. Based on the known ultrasonic speed, the echo propagation time is a measure for the distance to the obstacle.

### ■ Activating System

The PDC must be switched on, by engaging reverse gear, in order to activate the distance signalling function.

The PDC receives the signal information via the K-CAN:

- Manual transmission vehicles - the Footwell Module reads the signal from the gearshift lever and makes it available via the K-CAN
- On automatic transmission vehicles - the automatic transmission control unit sends the signal via the PT-CAN to the Junction Box Electronics Control Module, which makes the signal available via the K-CAN.

The PDC can also be activated by means of the button in the center console switch cluster. The signal from the button is received by the IHKA which transmits it via the K-CAN to the PDC.

### ■ Audible Distance Signaling

The distance is signalled audibly by means of the audio system, which receives the distance signals from the PDC via the K-CAN.

Both the RAD2 and the CCC make it possible to distinguish between left and right.

### ■ Visual Distance Signaling

Visual distance signaling can be displayed on the CID if the vehicle is equipped with a Car Communication Computer (CCC).





# Exterior Lighting

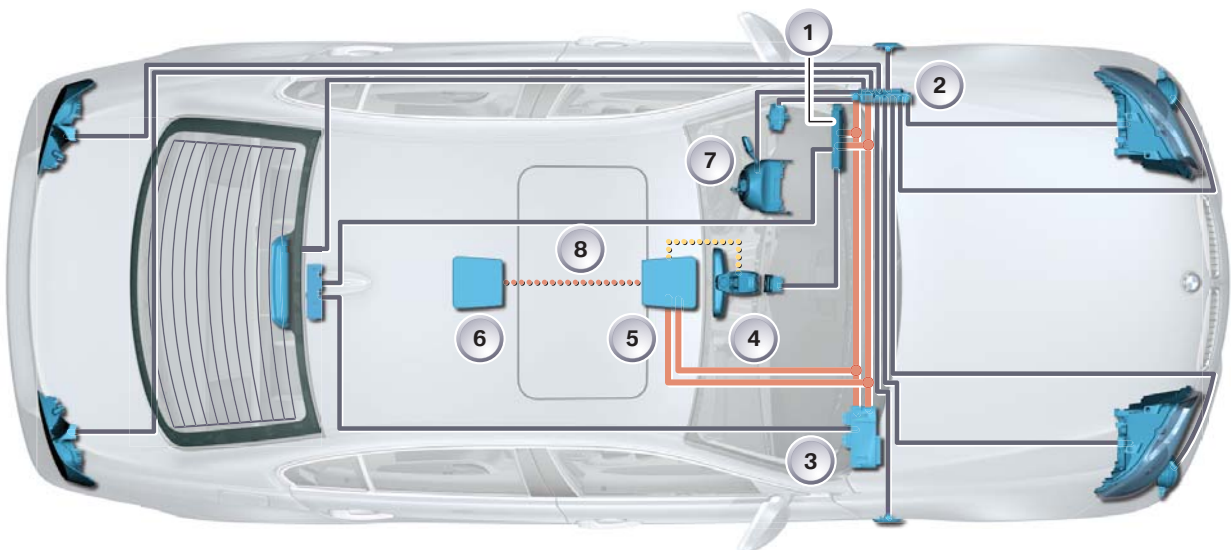
The standard exterior lighting system on the E90 consists of:

- Front headlights with:
  - Side Light
  - Low Beam Headlight
  - High beam
- Direction Indicator
- Brake Light
- Third Brake Light
- Front Direction Indicator Light Repeater
- Tail Lights
- Reverse Light
- Fog Lights
- Rain Light Sensor and Automatic Driving Lights Control

The following exterior lighting system option is available on the E90:

- Bi-xenon Headlight (SA 522) in conjunction with Adaptive Headlight (SA 524)

## Control Modules for Exterior Lighting



Index	Explanation	Index	Explanation
1	Car Access System (CAS2)	5	Roof Function Center (FZD)
2	Footwell Module (FRM)	6	Ultrasonic Passenger Compartment Sensor (USIS)
3	Junction Box Control Module (JBE)	7	Steering Column Switch Cluster (SZL)
4	Rain Light Sensor (RLS)	8	Multiple Restraint System (MRS5)

---

## **Footwell Module (FRM)**

The Footwell Module (FRM) is the master control module for all exterior lighting functions.

All exterior light systems (headlights and side/parklights) are switched on and off via the light switch. Information to turn the lights on or off is supplied from the light switch directly to the FRM.

The SZL directly provides information to flash headlights, activate high beams or activate turn signal indicators to the FRM via a hard wired connection for this stalk.

In the “automatic” driving lights setting, the FRM indirectly receives information for switching the vehicle lighting on/off from the Rain Lights Sensor (RLS).

*Signal path: RLS via LIN-BUS to FZD; FZD via K-CAN to FRM to headlights.*

The hazard light switch is connected directly to the FRM.

## **Junction Box Electronics Control Module (JBE)**

The Junction Box Electronics Control Module provides a pass-through function for the signals from the SZL, which are transmitted on the F-CAN to the DSC module.

## **Junction Box (JB)**

The power to the FRM is supplied from the Junction Box

## **Car Access System 2 (CAS2)**

The Car Access System provides ignition switch information to the FRM

## **Roof Function Center (FZD)**

The Roof Function Center transfers/routes the information from the RLS to the FRM via the K-CAN. The RLS provides information to activate/deactivate the headlights based on the level of exterior brightness.

## **Ultrasonic Passenger Compartment Protection Sensor (USIS)**

If the alarm system is installed (Center installed accessory), in the event of a triggered alarm, a request is sent to the FRM to trigger a visual alarm by flashing the lights. Flashing of the lights in association with arming and disarming the alarm system can be set as part of the vehicle memory/individualization function using the diagnostic equipment.

## **Multiple Restraint System (MRS5)**

In the event of a crash the MRS5 sends a request to the FRM to activate the hazard lights and illuminate the interior lights



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## Exterior Lighting Functions

Side Lights, Low Beam and High Beam are activated as follows:

Light Function	Activation by	Terminal
Side Lights	Light Switch, Stage 1	Term. 30
Low Beam Headlight	Light Switch, Stage 2	Term. 15 ON
High Beam	Briefly press Turn Signal Stalk on SZL Forward	Term. 15 ON
Headlight Flasher	Pull Turn Signal Stalk on SZL Back	Term. R ON

### Automatic Headlamp Control

The driving lights are switched on together with the side lights by the automatic driving lights control system, activation of the lights is based on input from the RLS depending on the ambient lighting conditions (tunnel, twilight, rain or snow). The function is activated by having the light switch in the Auto headlamp position.

In the event of a malfunction with the RLS the FRM will illuminate the headlamps.

**NOTE: The automatic headlamp control cannot serve as a substitute for personal judgement in determining when the lamps should be illuminated. As an example the system can not detect fog and should be activated manually.**

On vehicles equipped with iDrive the sensitivity of the lighting activation point can be adjusted by selecting Vehicle Settings - Lighting - Auto Headlamps.

### Fog Light

Foglights are activated by pressing the foglight button; side/park lights or low beam headlamps must be illuminated in order to activate the foglamps.

### Directional Indicators

The front and rear turn signal indicators are activated via the turn signal stalk on the SZL, an optical switch.

A defective bulb in the front or rear indicator lights will result in the remaining lights flashing at double the normal rate. If a repeated light is defective this will have no impact on flash rate.

The one touch function will flash/activate the indicators lights three times. The function can be modified via personal profile/individualization/vehicle memory.

### Hazard Lights

The hazard lights are activated by depressing the hazard light switch located in the center of the dash. The turn signal indicators have priority if the hazard flashers were activated first. The hazard flashers have priority if the turn signal indicators are active first.

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If equipped with an alarm system the hazard lights are flashed for up to 6 minutes if an alarm is triggered and the alarm is not switched off. The FRM receives the request via the K-CAN from the USIS module.

The FRM provides information to the instrument cluster via the K-CAN to activate the audible indicator as well as the visual indicator.

Upon activation of the central locking function CAS2 supplies a signal to the FRM via K-CAN to flash the hazard lights to indicate that the vehicle is locked. The visual feedback can be deactivated in the personal profile/vehicle memory settings.

### **Tail Lights/License Plate Lights**

In the event of a malfunction the lamps in the brake light chambers are used as a substitute for the taillight. The bulbs are dimmed by means of a PWM signal in order to provide a substitute tail light operation.

### **Brake Lights & Brake Force Display**

The brake light switch is powered by a 5V signal from the CAS2, with terminal R ON.

- Brake force display is standard on the E90 and is activated
- Speed > 5 Km/h
- Brake deceleration above 5 m/s<sup>2</sup>

### **Reverse Lights**

On vehicles equipped with an automatic transmission, the signal for activating the reverse light is obtained by the FRM from the EGS module via PT-CAN. On vehicles equipped with a manual transmission the FRM obtains the signal from the reverse gear switch.

### **Lamp Monitoring**

The Footwell Module (FRM) monitors all of the exterior lighting system with the lights switched on or off, as long as terminal 15 is active.

#### **■ Cold Monitoring with Lights OFF**

Cold monitoring is based on measuring the current of the individual lamp outputs. The current pulse used for measurement purposes is so short that the lamps are not illuminated. The FRM evaluates the individual lamp outputs to establish whether there is a line break or a lamp bulb is defective.

The number of current pulses is increased significantly during the first 4 s after terminal 15 ON to check whether the lamps are in working order before setting off. This function is referred to as the pre-drive check. The number of pulses is then reduced after the pre-drive check. Power is then applied to the lamps every 1.5 minutes.

The raised (3rd) brake light is not included in the cold monitoring system. The LEDs of the brake lamp react too fast to the current pulse and would consequently light up.

The bi-xenon headlight is also not included in the cold monitoring. Legal regulations prohibit the current pulse to the bi-xenon headlight.

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### ■ **Hot Monitoring with Lights ON**

Hot monitoring is based on measuring the current of the individual lamp outputs. The lamp current is used to detect an overload or interruption (break).

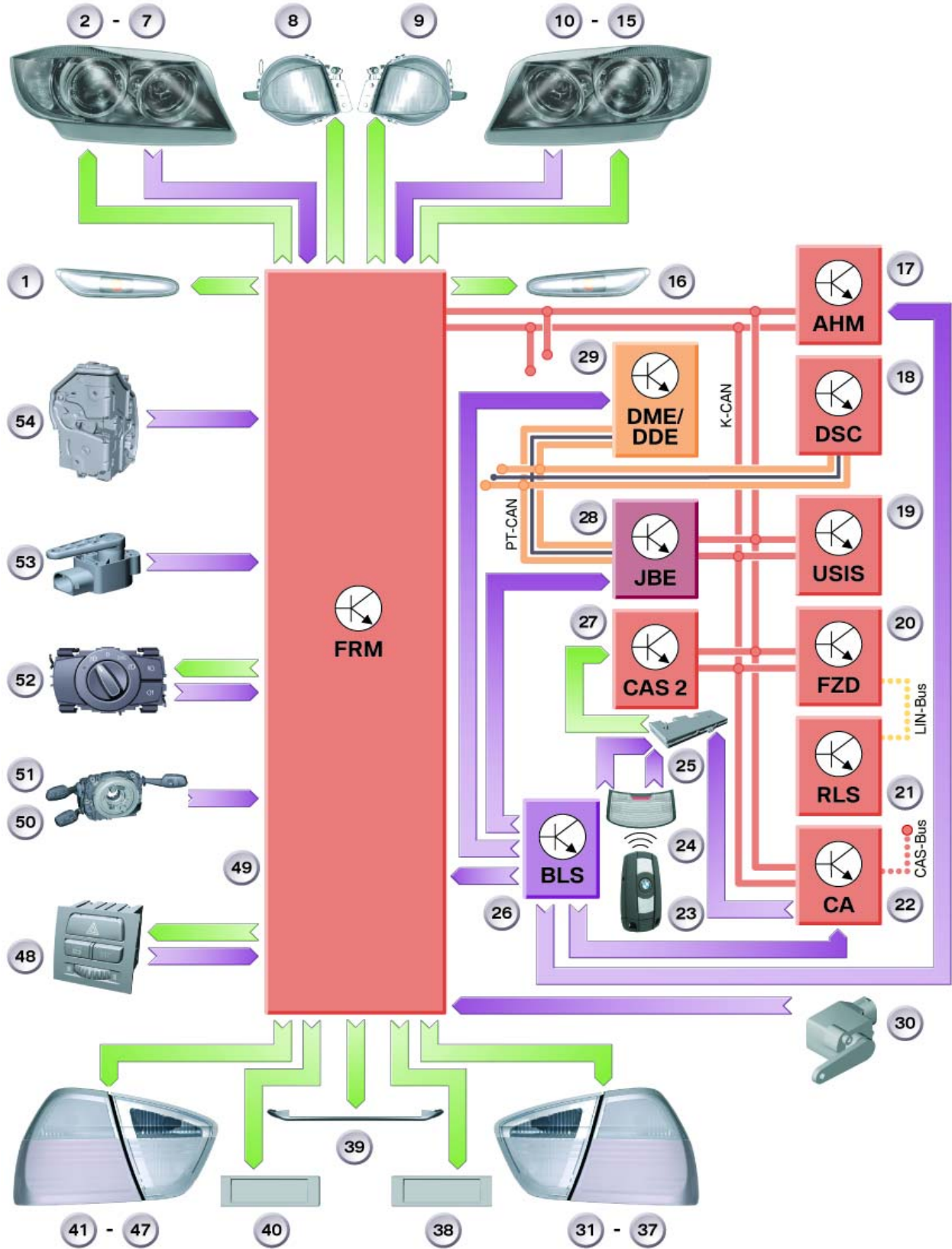
### **Pathway/Follow Me Home Lighting**

The lighting feature is activated by way of the headlight flasher position on the SZL stalk.

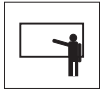
### **Bi Xenon Headlights**

The Bi Xenon headlights are only installed on the E90 in conjunction with the Adaptive Headlight Control System.

# Vehicle Exterior Lighting - Circuit Diagram



<b>Index</b>	<b>Explanation</b>	<b>Index</b>	<b>Explanation</b>
1	Direction Indicator Repeater, left	31-37	Rear Light Components, Right
2-7	Headlight, Left	31	Direction Indicator Light, Right
2	Stepper Motor for Dynamic Headlight Vertical Aim Control, Left	32	Tail Light, Right
3	Direction indicator Light, Left	33	Brake Light, Right
4	High Beam Shutter, Left	34	Brake Force Display, Right
5	Side Light, Left	35	Rear Fog Light, Right
6	Low Beam Light, Left	36	Tail Light, Right
7	High Beam Light, Left	37	Reversing Light, Right
8	Front Fog Light, Left	38	License Plate Light, Right
9	Front Fog Light, Right	39	Raised Brake Light
10 - 15	Headlight, Right	40	License Plate Light, Left
10	High Beam Light, Right	41-47	Rear Light Components, Left
11	Low Beam Light, Right	41	Reversing Light, Left
12	Side Light, Right	42	Tail Light, Left
13	High Beam Shutter, Right	43	Rear Fog Light, Left
14	Direction Indicator Light, Right	44	Brake Force Display, Left
15	Stepper Motor for Dynamic Headlight Vertical Aim control, right	45	Brake Light, Left
16	Direction Indicator Repeater, Right	46	Tail Light, Left
17	N/A	47	Direction Indicator Light, Left
18	Dynamic Stability Control (DSC)	48	Hazard Warning Switch
19	Ultrasonic Passenger Compartment Protection (USIS)	49	Footwell Module (FRM)
20	Roof Functions Center (FZD)	50	Steering Column Switch, High Beam/Direction Indicator Lights
21	Rain & Lights Sensor (RLS)	51	Steering Column Switch Cluster (SZL)
22	Comfort Access (CA)	52	Light Switch
23	Identification Transmitter	53	Ride-Height Sensor, Front
24	Rear Window Antenna	54	Door Contact
25	Remote Control Receiver	PT-CAN	Powertrain CAN
26	Brake Light Switch (BLS)	K-CAN	Body CAN
27	Car Access System 2 (CAS 2)	LIN-Bus	Local interconnected Network Bus
28	Junction Box Elec. Control Module (JBE)	CAS-Bus	CAS-Bus (K-bus protocol)
29	Digital motor electronics DME/ECM	FBD ON	Remote control services ON
30	Ride-height sensor, rear	FBD OUT	Remote control services OUT



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## Classroom Exercise - Review Questions

1. What module is responsible for the exterior lighting functions?

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2. How is the information for turn signal or high beam operation transferred to the FRM?

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NOTES

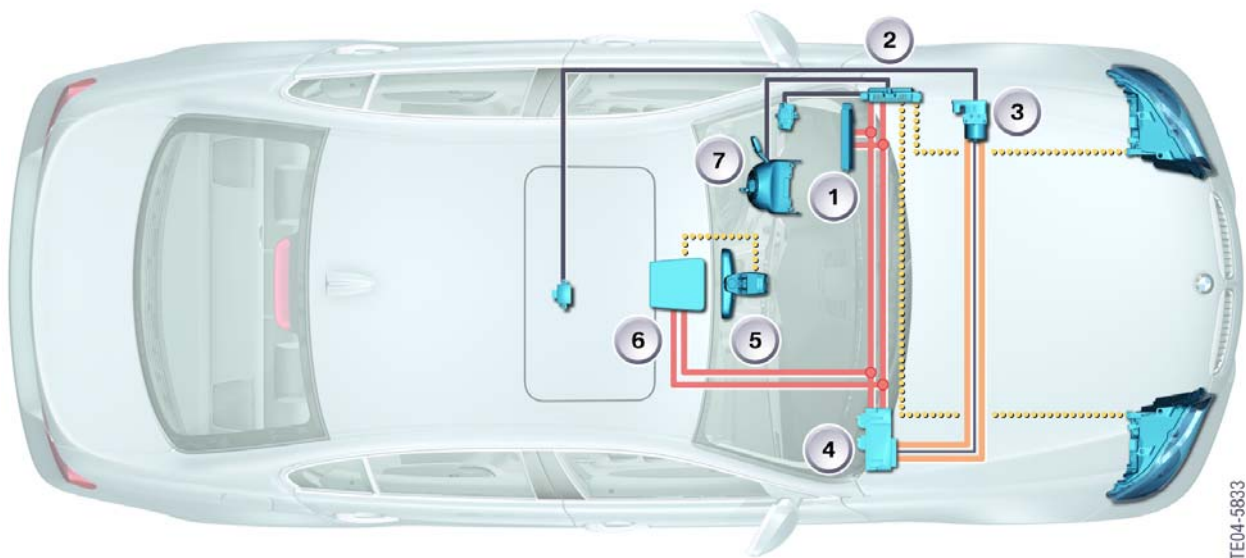
PAGE

# Adaptive Headlight Control

In conjunction with the Bi-Xenon headlights an Adaptive Headlight control system is also included on the E90.

The function of the Adaptive Headlight Control system is to provide an enhanced lighting path as the vehicle travels through a turn, plus reduce the risk of excessive glare to on coming traffic. The adaptive headlight control allows the headlights to rotate slightly as the front wheels turn.

## Control Modules for Adaptive Headlight Control



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Index	Explanation	Index	Explanation
1	Car Access System (CAS2)	5	Rain Light Sensor (RLS)
2	Footwell Module (FRM)	6	Roof Function Center (FZD)
3	Dynamic Stability Control Module (DSC)	7	Steering Column Switch Cluster (SZL)
4	Junction Box Control Module (JBE)	-	Multiple Restraint System (MRS5) Ultrasonic Passenger Compartment Protection Sensor (USIS) - if installed



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## **Car Access System 2 (CAS2)**

The Car Access System 2 provides ignition switch information to the FRM.

## **Footwell Module (FRM)**

The control for the Adaptive Headlight is incorporated into the Footwell Module.

The FRM is connected to:

- K-CAN
- PT-CAN
- LIN-bus.

**Note: The FRM is not a gateway for the PT-CAN, however, it does serve as a gateway between K-CAN and LIN-bus.**

The FRM can receive data via the PT-CAN as well as the K-CAN and LIN-Bus, however it only transmits data via K-CAN and LIN-Bus.

In the event that the FRM is replaced the VIN must be entered and the module coded to the vehicle plus an adaptation process must be completed or the Complete adaptive headlight control function will not be active.

## **Dynamic Stability Control (DSC)**

The dynamic stability control sends signals relating to the yaw rate and vehicle speed to the FRM for the operation of the Adaptive Headlight Control function

## **Junction Box Electronics Control Module (JBE)**

The signals that are sent via the F-CAN pass-through the JBE, making it possible to transmit the steering angle data from the steering column switch cluster to the FRM.

*Signal Path: Steering angle sensor in SZL via F-CAN to DSC; DSC to FRM via PT-CAN*

## **Rain and Light Sensor (RLS)**

The rain and light sensor is incorporated in the base of the rearview mirror. The signals from the RLS are used to switch on the automatic driving lights and activate the Adaptive Headlight Control function in the FRM.

## **Roof Function Center (FZD)**

The Roof Functions Center is the gateway for the RLS, and transfers the LIN-Bus signal of the RLS via the K-CAN to the FRM.

## **Ultrasonic Passenger-Compartment Protection Sensor (USIS)**

The USIS transmits the signal for the visual alarm of the anti-theft alarm system via the K-CAN to the FRM.

## **Multiple Restraint System 5 (MRS5)**

The MRS5 supplies a signal to the FRM in the event of a crash.

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## **Additional Components of Adaptive Headlight Control**

### **Bi-Xenon Headlight**

The bi-xenon headlight control unit is mounted on the bi-xenon headlight and supplies the power and ignition voltage for the bi-xenon light bulb which is integrated in the swivel section of the adaptive headlight.

The zero position Hall sensor registers the zero position of the swivel module and the stepper motor provides the swivel movement of the swivel module.

A separate stepper motor is installed for the headlight vertical aim control.

The headlight can be replaced, however headlight-specific coding is necessary for the respective stepper motor controller. If this adaptation is not performed, the function will appear to operate, but not correctly.

The swivel range and zero point can vary from vehicle model to vehicle model and the bi-xenon headlight can have a different status! The headlights must be adjusted and checked.

### **Stepper Controller**

The stepper motor controller is mounted on the side of the bi-xenon headlight and controls/monitors the movement of the stepper motors for the adaptive headlight and the vertical aim control function.

The component can be replaced, however after replacing the stepper motor controllers, it is necessary to store the vehicle identification number and enter headlight related coding in the stepper motor controllers.

The complete adaptive headlight function will not be operative without this adaptation. Particular care must be taken when replacing the stepper motor controllers to ensure that the housing gasket of the stepper motor controller is fitted and seals correctly.

### **Directional Indicator/High Beam Switch**

The SZL contains the direction indicator/high beam switch and provides this signal directly to the FRM via a hard-wired connection.

### **DSC Sensor**

The DSC Sensor provides information pertaining to the yaw of the vehicle about the vertical axis

### **Rotation Rate Sensor**

The rotation rate sensors supply the signals for the vehicle speed via DSC to the FRM.

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## **Steering Angle Sensor**

The Steering Angle Sensor is integrated in the SZL, is an optical sensor, and makes available data relating to the steering wheel angle.

## **Front and Rear Ride-Height Sensors**

The ride-height sensors are installed on the front and rear axle.

The signals of the ride-height sensors are used for the headlight vertical aim control and are evaluated by the FRM.

## **Brake Pedal Switch**

The signal of the brake pedal switch is used by the FRM to adjust for the headlight vertical aim control.

## **Diagnosis Mode**

The adaptive headlight must be set to diagnosis mode for following diagnosis tasks:

- Read out of relevant bus signals with vehicle stationary
  - Road speed
  - Yaw rate
  - Steering angle
- Checking signal plausibility
- Checking that conditions for activation are fulfilled
  - Rain and light sensor status
  - Light switch status.

Missing or non-plausible BUS signals are stored in the form of fault codes in the FRM. The fault types are stored in the stepper motor controller.

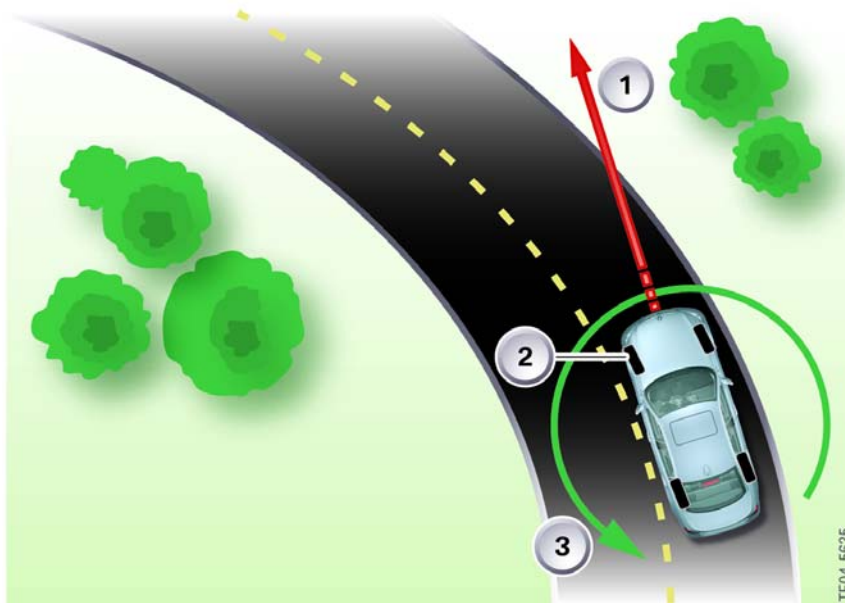
The stepper motor controller is accessed via the FRM.

**Note: If headlight rotation function is being checked while vehicle is standing still the headlight will only rotate to the right.**

## Headlight Rotation

In order for the headlights to rotate slightly as the front wheels are turned, a stepper motor is incorporated into the headlight assembly/swivel module. The FRM controls the amount of rotation based on the following information:

- Steering angle
- Road speed
- Yaw rate.



Index	Explanation
1	Vehicle Speed
2	Steering Angle
3	Yaw Rate

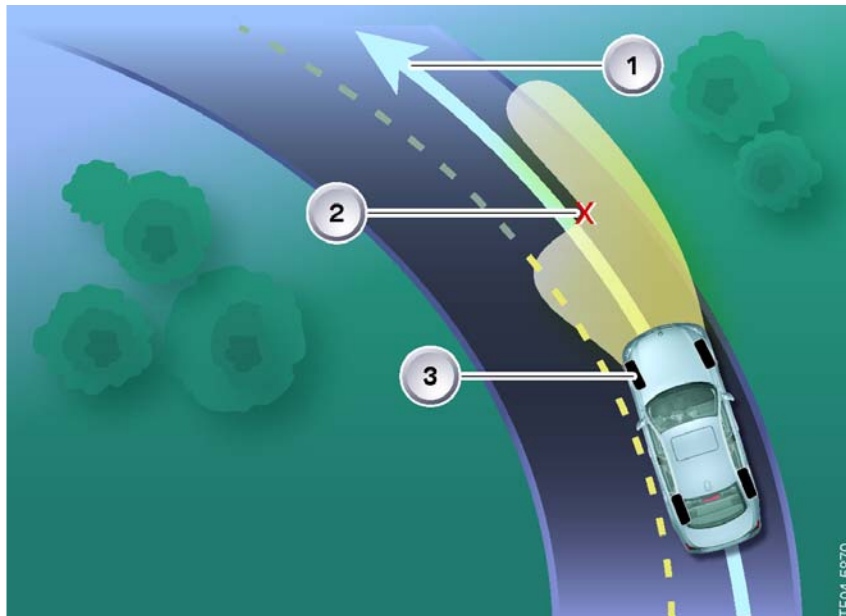
Under normal driving conditions up to a speed of approx. 40 km/h, the adaptive headlight is controlled by the data from the steering angle sensor.

The information from the yaw rate sensor is included in the calculation for headlight rotation:

- At speeds greater than approx. 40 km/h
- In the event of vehicle oversteering or understeering
- A vehicle tending to yaw.

The adaptive headlight rotation function is deactivated in the event an oversteering, understeering or yawing condition is detected by means of the steering angle sensor and the yaw rate sensor. If the adaptive headlight function is deactivated the stepper motor/swivel module returns to its zero position.

In normal operation the Adaptive Headlight Control function allows the front headlight to rotate slightly as the vehicle moves through turns.



Index	Explanation
1	Anticipated Circular Path
2	Transition Point Light/Dark Limit
3	Steering Angle

The transition point of light/dark must be above the center line of travel when the vehicle is in a turn to reduce the risk of excessive glare to on coming traffic.

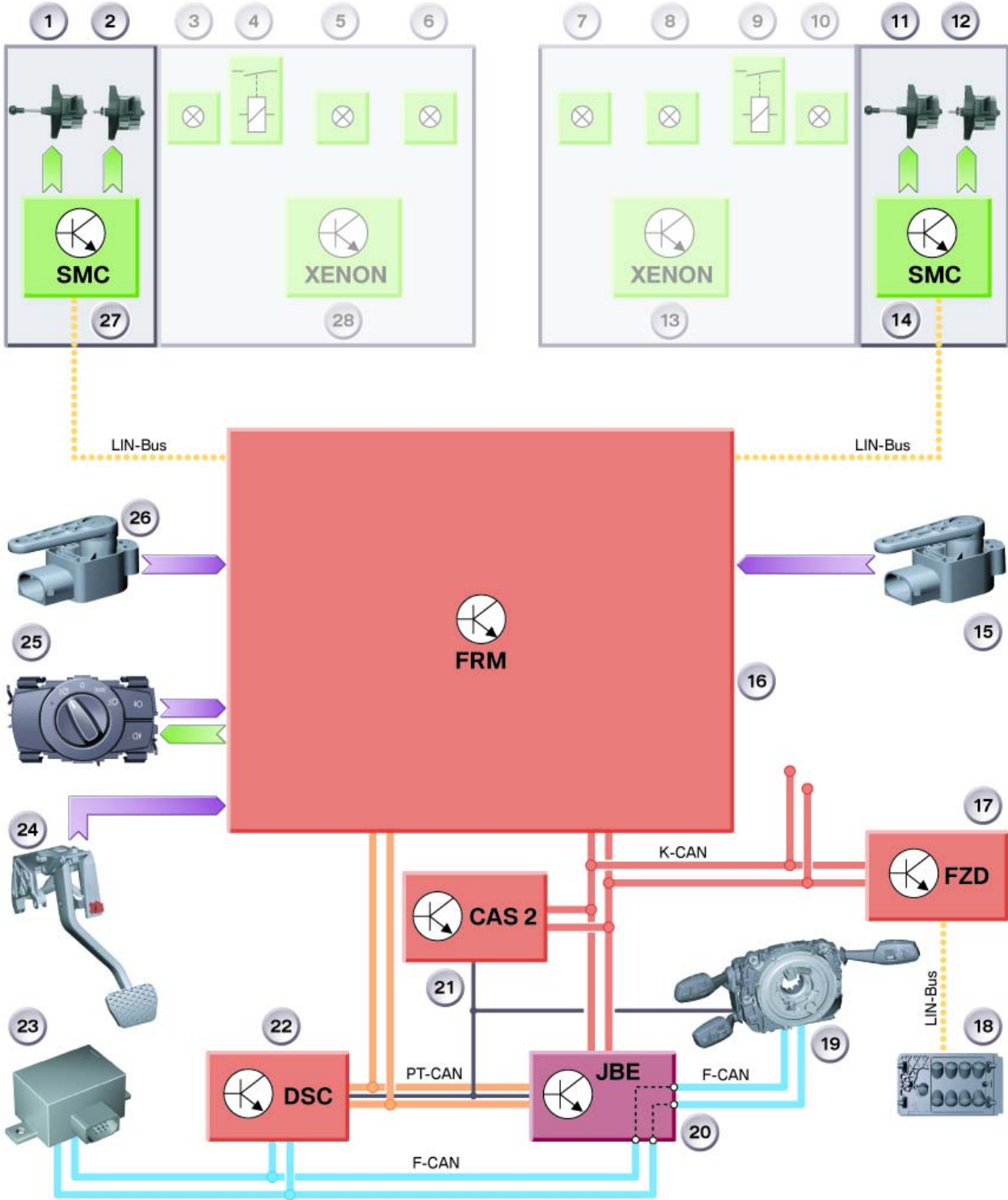
It is the responsibility of the stepper motor controller based on information received from the FRM via LIN-Bus, to control and monitor the stepper motors of each headlight plus the vertical aim control of the respective bi-xenon headlight.

The stepper motor controller performs the following functions:

- Receiving and evaluating the data sent from the FRM via the LIN-bus:
  - Reference run
  - Target position commands
  - Diagnosis requests
- Output control of the stepper motors
- Zero position acquisition of swivel module
- Reference run of swivel module
- Position feedback of swivel module to footwell module
- Diagnosis
- Feedback of diagnosis data to the footwell module.

The FRM in its function as the central control unit for the adaptive headlight sends signals to the stepper motor controllers every 20 ms.

# Adaptive Headlight Control - Input/Output



## Legend for Adaptive Headlight Control

Index	Explanation	Index	Explanation
1	Stepper motor for dynamic headlight vertical aim control, left	19	Steering Column Switch Cluster (SZL)
2	Stepper motor for adaptive headlight, left	20	Junction Box Electronics Control Module (JBE)
3	Side light, left	21	Car access system 2 CAS 2
4	High beam shutter, left	22	Dynamic Stability Control (DS)
5	Bi-xenon light bulb, left	23	Dynamic stability control sensor DSC-SEN
6	High beam light, left	24	Brake light switch BLS
7	High beam light, right	25	Lights operating unit
8	Bi-xenon light bulb, right	26	Ride-height sensor, front
9	High beam shutter, right	27	Stepper motor controller SMC
10	Side light, right	28	Bi-xenon control unit, left
11	Stepper motor for adaptive headlight, right	LIN-Bus	Local interconnected network bus
12	Stepper motor for dynamic headlight vertical aim control, right	K-CAN	Body bus
13	Bi-xenon control unit, right	PT-CAN	Powertrain CAN
14	Stepper motor controller SMC, right	F-CAN	Chassis CAN
15	Ride-height sensor, rear	KI. R	Terminal R
16	Footwell Module (FRM)	KI. 54	Terminal 54
17	Roof Functions Center (FZD)	KL. 54T	Terminal 54T
18	Rain and Lights Sensor (RLS)		





## Legend for Adaptive Headlight Control

Index	Explanation	Index	Explanation
1	Stepper motor for dynamic headlight vertical aim control, left	19	Steering Column Switch Cluster (SZL)
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15	Ride-height sensor, rear	KI. R	Terminal R
16	Footwell Module (FRM)	KI. 54	Terminal 54
17	Roof Functions Center (FZD)	KL. 54T	Terminal 54T
18	Rain and Lights Sensor (RLS)		



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## Classroom Exercise - Review Questions

1. What module is responsible for the Adaptive Headlight Control function?

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2. What is the purpose of Adaptive Headlight Control?

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3. What signals/information are required for the operation of the Adaptive Headlight Control function?

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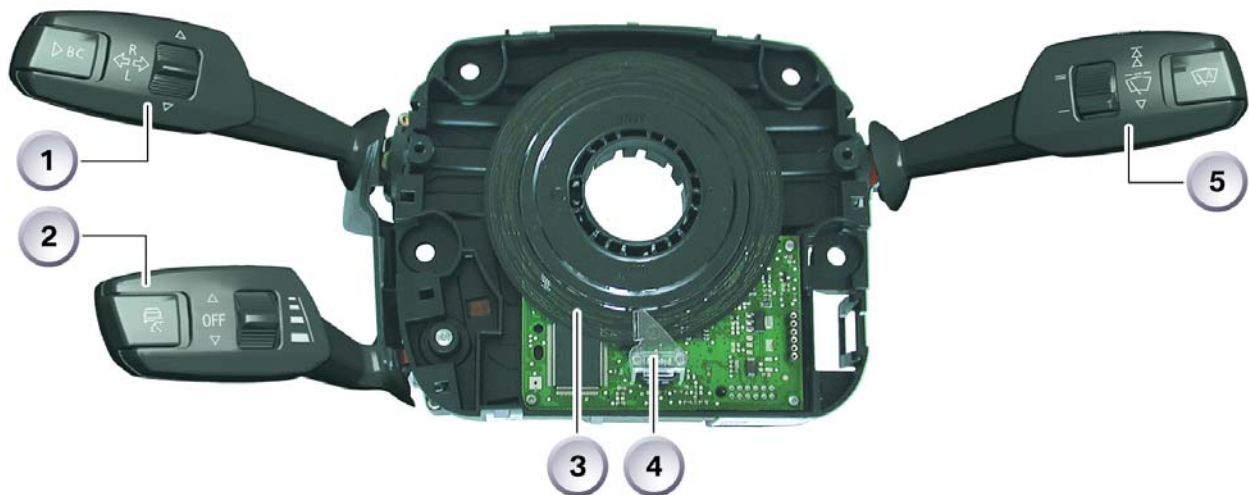
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# Steering Column Switch Cluster

The functions of the Steering Column Switch Cluster (SZL) are:

- Detecting steering angle and steering speed
- Detecting the controls in the multifunction steering wheel (MFL)
- Detecting switching signals in the steering column switches
- Sending and receiving information to/from the interlinked control modules.

## Components of the SZL



Index	Explanation
1	Steering Column Switch, Direction Indicator/High Beam Stalk
2	Steering Column Switch, Cruise Control
3	Code Disc
4	SZL with Optical Sensor
5	Wiper Steering Column Stalk with Buttons for Rain and Driving Lights Sensor

**NOTE:** The steering column switch cluster SZL can only be replaced as a complete unit. The coil spring assembly is installed on the steering column switch cluster which can be removed and individually replaced.

The Electronic Steering Column Switch Cluster module contains a processor, power supply and the following interfaces:

- F-CAN
- Optical switches
- Electrical switches.

The optical sensor for measuring the steering angle is integrated in the pc-board of the control module.

### F-CAN Link

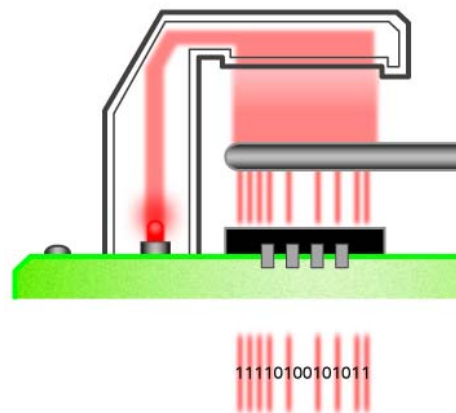
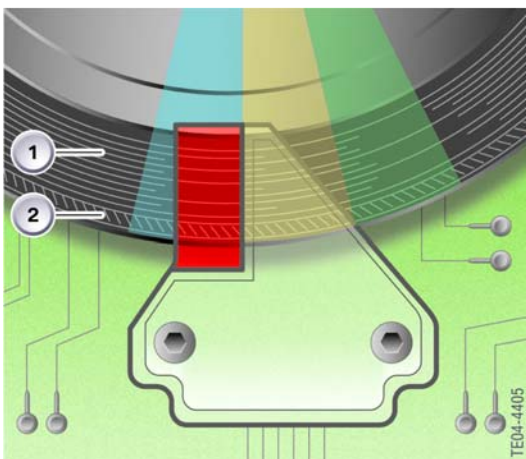
The DSC control module is connected via the F-CAN to the SZL and serves as the gateway for the SZL, allowing data from the SZL to be distributed to the other control modules.

All diagnosis functions take place via the DSC control module.

There is no fault code memory in the SZL, since the SZL cannot communicate directly with the BMW diagnosis system.

### Detection of Steering Angle and Steering Speed

The steering column switch cluster must detect the steering angle and steering speed information as the basis for calculating various functions in the DSC. Additional information such as the absolute steering angle or the steering wheel rotation information is calculated by the SZL

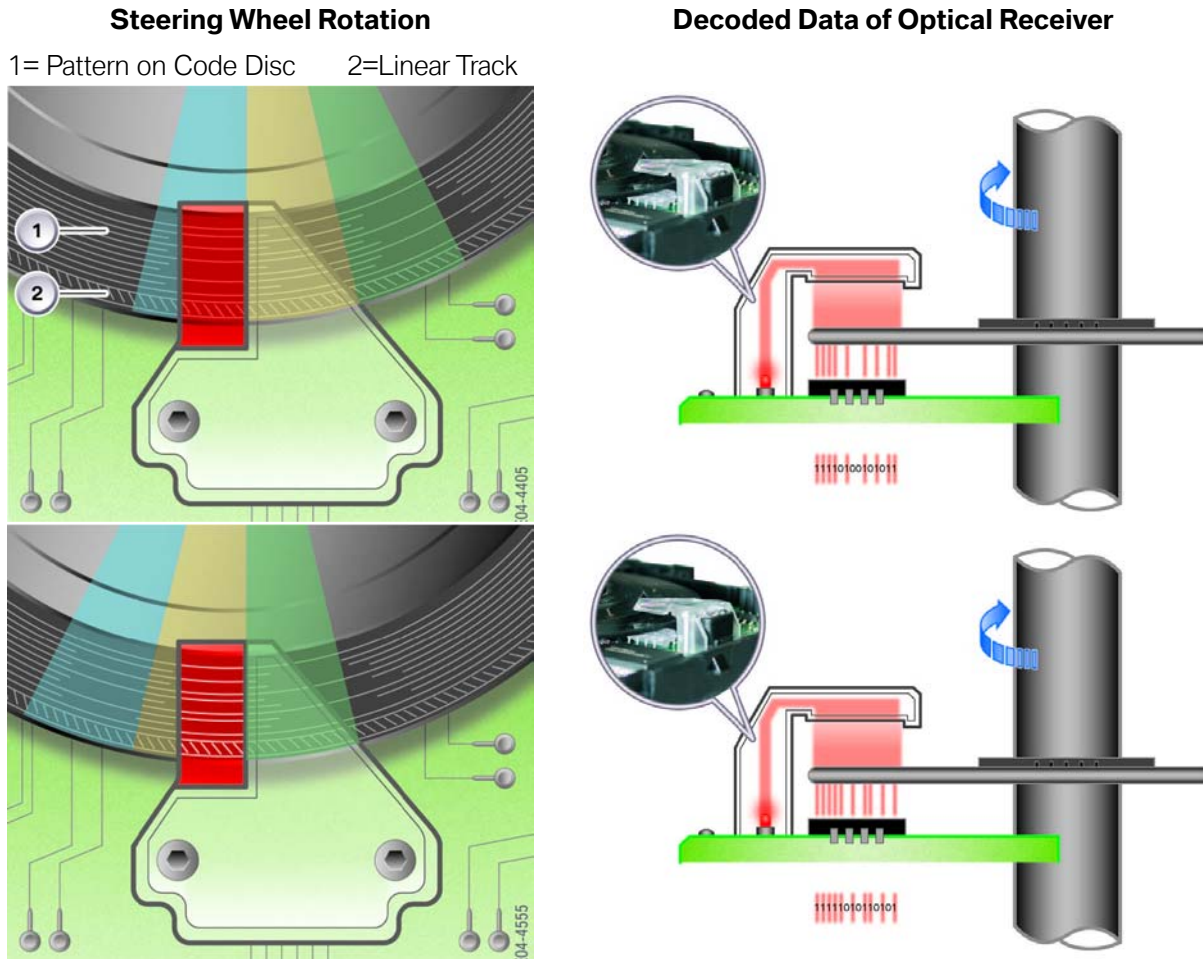


The optical steering angle sensor is able to detect a steering angle of  $-180^{\circ}/+180^{\circ}$ .

In order to measure the steering angle a “code” disc rotates as the steering wheel is rotated. An LED and fibre optics unit illuminate the code disc from above and based on the pattern on the code disc, the light from above reaches the bottom receiver/camera only in certain areas. The light pulses received by the receiving unit are converted to electrical pulses by the sensor.

The pattern (1) on the disc changes in  $2^{\circ}$  increments, by evaluating the linear track (2) the steering angle can be defined to  $0.1^{\circ}$

As the steering wheel is rotated the information contained in the pattern on the code disc (1) as well as the on linear track (2) changes. The changing information is “decoded” by the optical receiver and converted to electrical pulses to define the angle that the steering wheel has been rotated. Relative steering angle ( $\pm 180^\circ$ )



■ **Relative Steering Angle (+/- 180°)**

The relative steering angle indicates the angle position of the steering wheel. The information relating to the relative steering angle is always retained even when power to the control module is disconnected. Renewed zero point adjustment/ calibration is necessary only after the steering column switch cluster SZL has been replaced. DSC module is reprogrammed/replaced or after completing any repairs on the steering wheel/ steering column.

■ **Absolute Steering Angle**

The absolute steering angle is a calculation based on the relative steering angle and steering wheel rotation information. The absolute and relative steering angle are defined during the zero point adjustment of the steering column switch cluster. The SZL detects each position of the steering wheel over the entire steering lock range. The precondition before any zero point adjustment procedure is that the wheels and steering wheel are set in the straight-ahead position.

---

## **Detecting the Controls of Multifunction Steering Wheel**

The voltage signals of the buttons on the multifunction steering wheel are routed via the coil spring to the SZL. The SZL evaluates the voltage signals and sends the information to the corresponding control units.

The connections of the Steptronic switches, horn and the driver airbag are wired directly via the coil spring to the corresponding control units. This information is therefore not evaluated in the SZL.

Detecting the signals of the steering column switches Optical switches are used in connection with the steering column stalks on the E90. Optical sensors detect the stalk position and makes this information available to the SZL.

### ■ **Direction Indicator/High Beam Switch**

The signals of the direction indicator and high beam switch are monitored by the SZL and transferred via three voltage-coded lines to the FRM. Only information relating to the switch positions is transmitted.

The signals of the on-board computer button and the rocker switch are transferred via a line from the SZL to the Instrument Cluster.

The functions in the respective switch positions are defined in the control modules.

### ■ **Wiper Switch**

The signals of the wiper switch are calculated directly in the SZL and transferred via the F-CAN to the DSC and to the Junction Box Electronics Control Module

### ■ **Cruise Control Switch**

The signals for the DCC or ACC systems are made available to the LDM. The data is transmitted via the F-CAN to the DSC. From the DSC the data are forwarded via the PT-CAN to the LDM.

## **Signal Flow**

The acquired and calculated data of the SZL are mainly transferred via the F-CAN to the corresponding control module.

The information for diagnosis is therefore also transferred via the F-CAN to the DSC. The DSC establishes the communication interface with the BMW diagnosis system. The SZL cannot be addressed directly via the BMW diagnosis system.

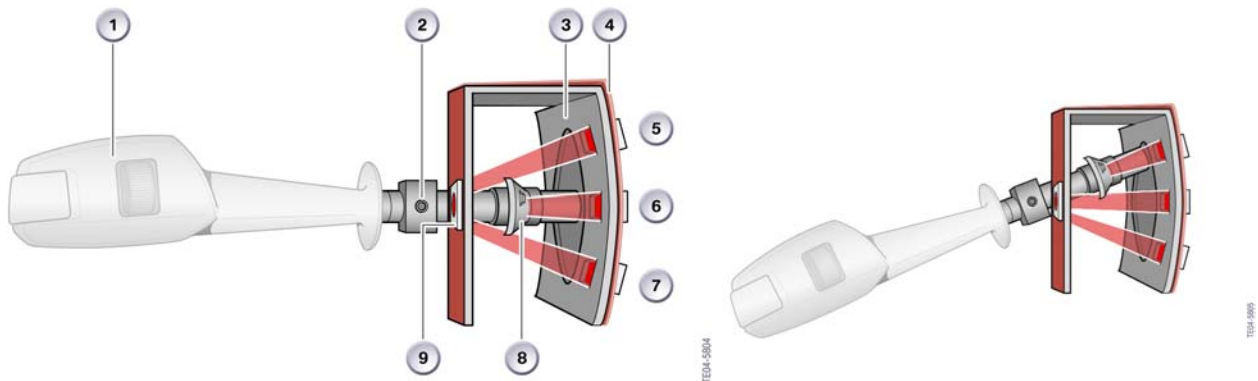
The DSC must be coded after replacing the steering column switch cluster. The coding data is then transferred from the DSC to the SZL.

## Steering Column Switches

The settings of all steering column stalks are determined optically.

### Function

Depending on the steering column stalk, there are three or four LEDs on the outside and one optical receiver (LDR light-dependent resistor) on the inside of the steering column housing of the steering column stalk. A shutter is provided on the steering column stalk which, when in rest position, is located between the center LED and the LDR. As a result, the shutter blanks out the light of the center LED when in rest position.



Index	Explanation	Index	Explanation
1	Steering Column Switches	5-7	LED
2	Pivot point of Steering Column Stalk	8	Cover/shutter
3	Retaining Fixture	9	Light Dependent Resistor (LDR)
4	Conductor		

As soon as the steering column stalk is moved, the shutter moves up or down and one of the outer LEDs is covered. The LEDs are never activated together but always clocked one after the other. In this way, the electronic SZL module can detect which LED is currently blanked out. The function can be monitored by measuring the current at the LED.

The data from the buttons and thumbwheels in the steering column switches is converted to a voltage signal and either routed to the SZL and distributed to the corresponding control modules (wiper switch - JBE) or forwarded directly to other control modules (Turn indicators/high beam - FRM).

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## Coil Spring Assembly

The coil spring assembly can be replaced only as a complete unit. The task of the coil spring is to transmit the following electrical signals from and to the multifunction steering wheel:

- Activation of driver airbag
- Control buttons for SMG function (Not available at Launch)
- Multifunction buttons
- Horn

### ■ Locking

To avoid damaging the coil spring assembly, it must be set to the correct position when dismantling the steering wheel and coil spring assembly.

The front wheels and steering wheel must be set to the straight-ahead position as the prerequisite for disassembly. During disassembly of the steering wheel, the load on the lock pin of the coil spring assembly is relieved and the pin can lock in the straight ahead position.

When the steering wheel is reinstalled, this arrangement ensures that the coil spring is not damaged when the steering wheel is turned to full left and right lock.



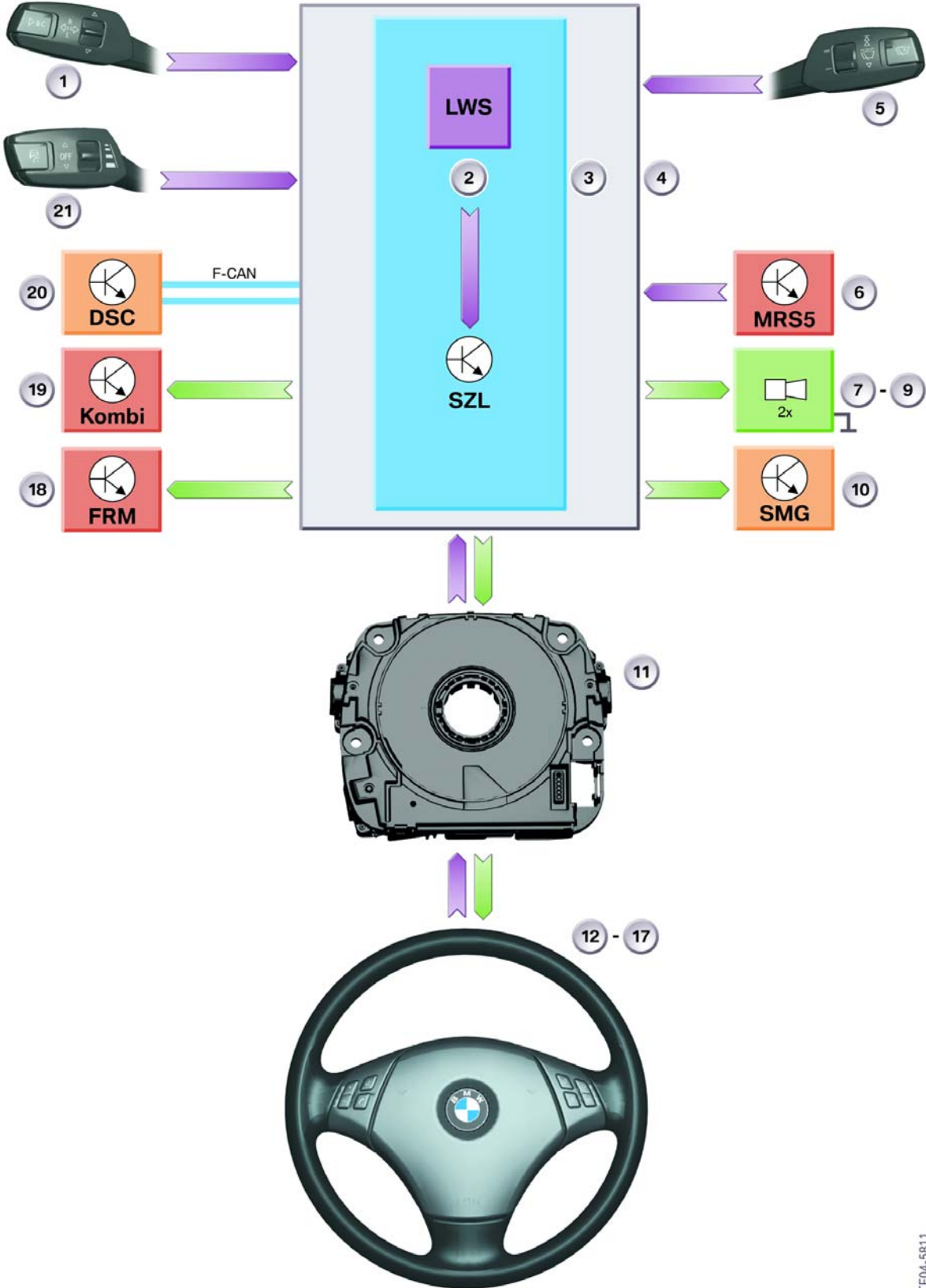


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NOTES

PAGE

# Steering Column Switch Cluster - Input/Output



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## Legend for Steering Column Switch Cluster

Index	Explanation	Index	Explanation
1	Steering column switch, direction indicator lights	16	2-stage driver airbag
2	Steering angle sensor	17	Multifunction buttons
3	Electronic steering column switch cluster module	18	Footwell module FRM
4	Steering column switch cluster	19	Instrument cluster
5	Steering column switch, wipers	20	Dynamic stability control DSC
6	Multiple restraint system 5 MRS 5	21	Steering column switch, cruise control
7	Junction box JB	F-CAN	Chassis CAN
8	Fanfare relay	WUP	Wake-up line
9	Fanfare horn	Kl. 58g	Terminal 58g
10	Sequential manual gearbox SMG (not available at series launch)	Kl. 31	Terminal 31
11	Coil spring assembly	kl. 30	Terminal 30
12	Steering wheel	BC	On-board computer
13	Sequential manual gearbox button (not available at series launch)	FRA_L	Direction indicator light, left
14	Fanfare horn button	FRA_R	Direction indicator light, right
15	Sequential manual gearbox button (not available at series launch)	FL	High beam



## Legend for Steering Column Switch Cluster

Index	Explanation	Index	Explanation
1	Steering column switch, direction indicator lights	16	2-stage driver airbag
2	Steering angle sensor	17	Multifunction buttons
3	Electronic steering column switch cluster module	18	Footwell module FRM
4	Steering column switch cluster	19	Instrument cluster
5	Steering column switch, wipers	20	Dynamic stability control DSC
6	Multiple restraint system 5 MRS 5	21	Steering column switch, cruise control
7	Junction Box Electronics Control Module (JBE)	F-CAN	Chassis CAN
8	Fanfare relay	WUP	Wake-up line
9	Fanfare horn	Kl. 58g	Terminal 58g
10	Sequential manual gearbox SMG (not available at series launch)	Kl. 31	Terminal 31
11	Coil spring assembly	kl. 30	Terminal 30
12	Steering wheel	BC	On-board computer
13	Sequential manual gearbox button (not available at series launch)	FRA_L	Direction indicator light, left
14	Fanfare horn button	FRA_R	Direction indicator light, right
15	Sequential manual gearbox button (not available at series launch)	FL	High beam



## Classroom Exercise - Review Questions

1. What is new regarding the operation of the steering angle sensor? How does it operate?

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2. How is/are the positions of the steering column stalks determined?

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3. How is information from the SZL transmitted to other modules?

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# Outside Mirror

The following outside mirror functions are possible:

- Mirror adjustment in up/down and left/right directions
- Mirror heating
- Mirror folding function
- Electrochromatic mirror
- Outside mirror with memory function
- Automatic parking function
- Manual adjustment
- Motor protection by repeat interlock.

## Mirror Adjustment

The driver's door switch cluster is connected via the LIN-bus to the Footwell Module (FRM).

The mirror adjustment switch in the driver's door switch cluster is converted into a LIN-bus message.

The FRM checks the status of the driver's door switch cluster every 20 ms. The mirror adjustment switch sends a signal to the electronic module in the driver's door switch cluster which is then forwarded via the LIN-bus to the FRM.

To protect the mirror drive unit, the mirror adjustment is limited to a maximum activation time of 10 s. Activation is maintained within this period of 10 s until the mirror adjustment switch is released. Activation is also maintained until the outside mirror blocks or reaches its end position.

## Detecting Position of Outside Mirrors

The outside mirrors have two potentiometers for mirror adjustment, each potentiometer receives a 5 V supply from the electronic mirror module. The defined values of each potentiometer is stored in the FRM for the memory function.

## Mirror Heating

The mirror heating is activated with of terminal 15 ON, by the FRM and the corresponding information is passed on to the electronic mirror module via the LIN-bus.

The Instrument Cluster makes available the outside temperature value via the K-CAN. The Junction Box Electronics Control Module provides the information for the wipers via the K-CAN.

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The percentage of switch-on time is calculated from both values in the FRM.

Temperature in °C	< -10	-10 to 5	5 to 15	15 to 25	25 to 35	> 35
Heating capacity in %	100	75	50	0	0	0
Heating capacity with wipers ON in %	100	100	75	50	25	0

The percentage of increase is retained for 300 s after the wiper is switched off.

The maximum electric heating output is 18 W that is set by means of voltage and current measurement in the mirror.

### **Undervoltage**

The electronic mirror module switches off the mirror heating in the event of undervoltage, which has a positive effect on the charge balance of the battery. The cutout threshold is at 10.8 V.

The electronic mirror module switches on the mirror heating again once a voltage of 11.6 V is provided.

### **Terminal 50**

During the start procedure, the starter outputs the "terminal 50 ON" status and the mirror heating is switched off during this period of time.

### **Mirror Folding Function**

The folding function is controlled by the Footwell Module (FRM). When the mirror folding switch is pressed, the driver's door switch cluster evaluates the request and transfers it to the FRM.

The FRM receives the request via the LIN-bus. Both outside mirrors are folded in towards the vehicle thus reducing the vehicle width.

The outside mirror folding function is also possible in connection with the convenient closing function. The outside mirrors are activated at the same time as the rear power windows. The Car Access System 2 provides the signal necessary for this purpose.

### **Electrochromatic Outside Mirrors**

The automatic dip function of the outside mirrors is dependent on the setting of the interior rear-view mirror. The function is available with terminal 15 ON.

The interior rear-view mirror sends the request to dip the mirrors to the Roof Functions Center via the LIN-bus. In turn, the Roof Functions Center makes the request available on the K-CAN. The FRM sends this request via the LIN-bus to the outside mirrors.

The electronic mirror module controls the dip function of the outside mirrors.



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## Outside Mirror with Memory Function

The outside mirror features a memory function that is stored in the FRM. Three memory locations are available for this purpose: They are:

- Current position when leaving the vehicle
- Memory position of memory button 1
- Memory position of memory button 2

### Remote Control

Up to three personalizable remote controls are possible per vehicle.

When the vehicle is locked using the remote control, the current mirror position is stored in the memory location for the key memory of the remote control currently used. As a result, the mirror position last set, referred to the remote control used, is always re-assumed when the vehicle is unlocked.

### Storing Memory Position

The position of the outside mirrors is stored in the FRM by pressing the "M" button followed by pressing one of the memory buttons within 7 s. The driver's seat module evaluates the memory buttons and sends this information via the K-CAN.

### Calling up Memory Position

When the memory button is pressed, the driver's seat module receives the request to adjust the outside mirrors to the memory position.

The driver's seat module sends this request on the K-CAN. The FRM evaluates the request and activates the memory position.

## Automatic Parking Function

The outside mirror on the front passenger's side is swivelled downward when reverse gear is engaged so that the curb can be easily viewed. The automatic parking function is activated under following conditions:

- Terminal 15 ON and
- Reverse gear signal
- Mirror selector switch set to driver position
- Towing hitch must not be active.

### Manual Gearbox

The FRM receives the signal via the reverse gear switch. This switch refers to ground and sends out a low signal when reverse gear is engaged.

### Automatic Gearbox

The FRM receives the signal via the K-CAN. The automatic transmission control unit then makes this signal available.

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## Folding Mirror Manually

The outside mirrors can be folded in or out manually. The mirrors could lose their set position when folded in or out manually. It may be necessary to repeat the fold-in/fold-out function for the mirrors to find the set position.

## Motor Protection by Repeat Interlock

The outside mirrors feature a repeat inhibit function to avoid thermal overheating by frequently folding the mirrors in and out. The motors cannot be activated for 180 s when the repeat inhibit is active.

## Components of Outside Mirror Function

The following components are installed in the E90 for the purpose of operating the outside mirrors:

- Driver's door switch cluster with
  - Outside mirror adjustment switch
  - Outside mirror selector switch
  - LIN-bus link
- Outside mirrors
- Footwell Module
- Junction Box Electronics Control Module
- Components for comfort/convenience function
  - Car Access System 2
  - Lock cylinder, driver's door
  - Remote control receiver in interior rearview mirror

### Driver's Door Switch Cluster

In connection with the Low outside mirror, the adjustment motors are connected directly to the driver's door switch cluster.

In connection with the High outside mirror, the adjustment motors are connected via the electronic mirror module.

The electronic mirror module is connected via the LIN-bus to the driver's door switch cluster.

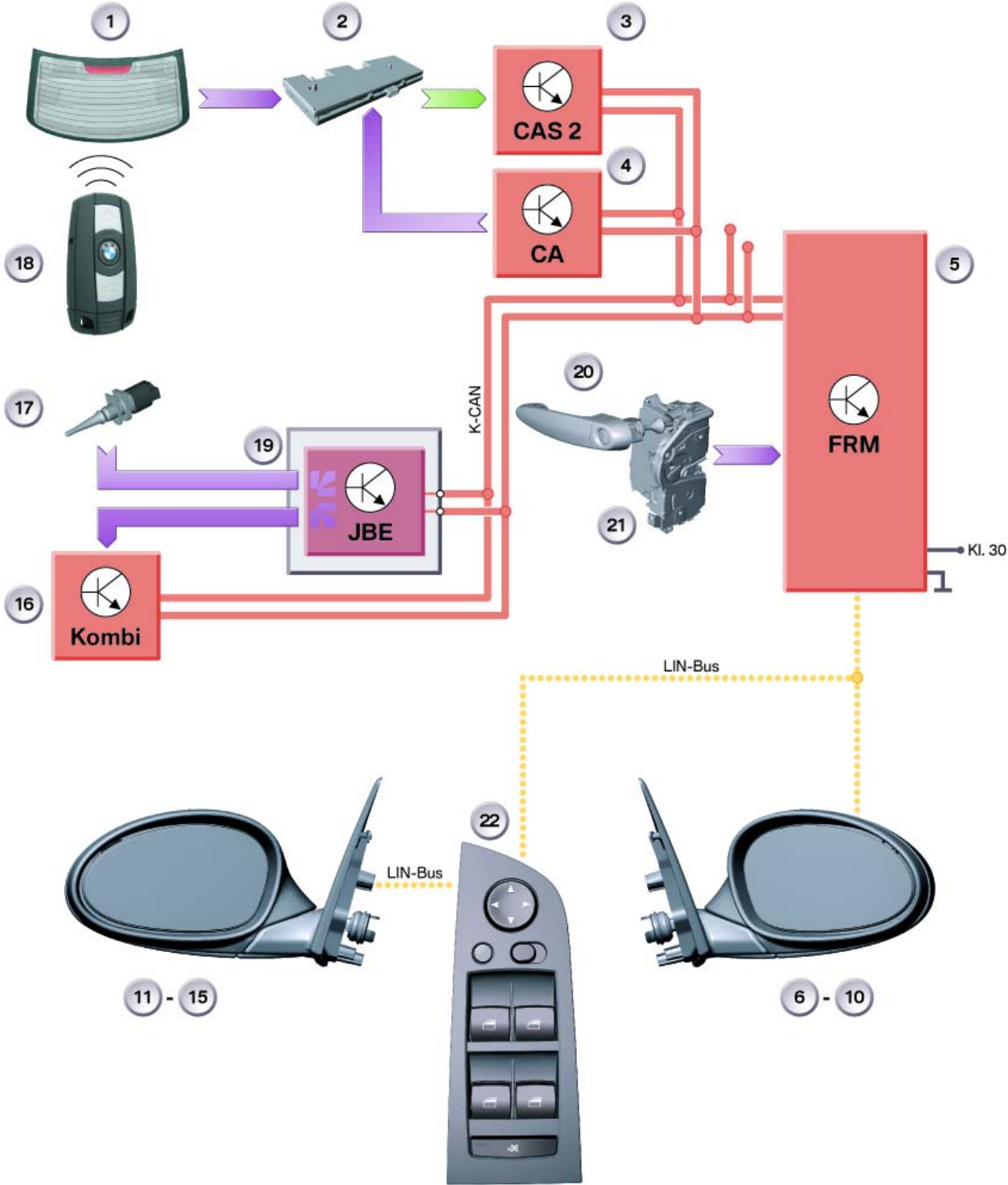
The driver's door switch cluster is connected via the LIN-bus to the FRM and therefore also to the vehicle electrical system.

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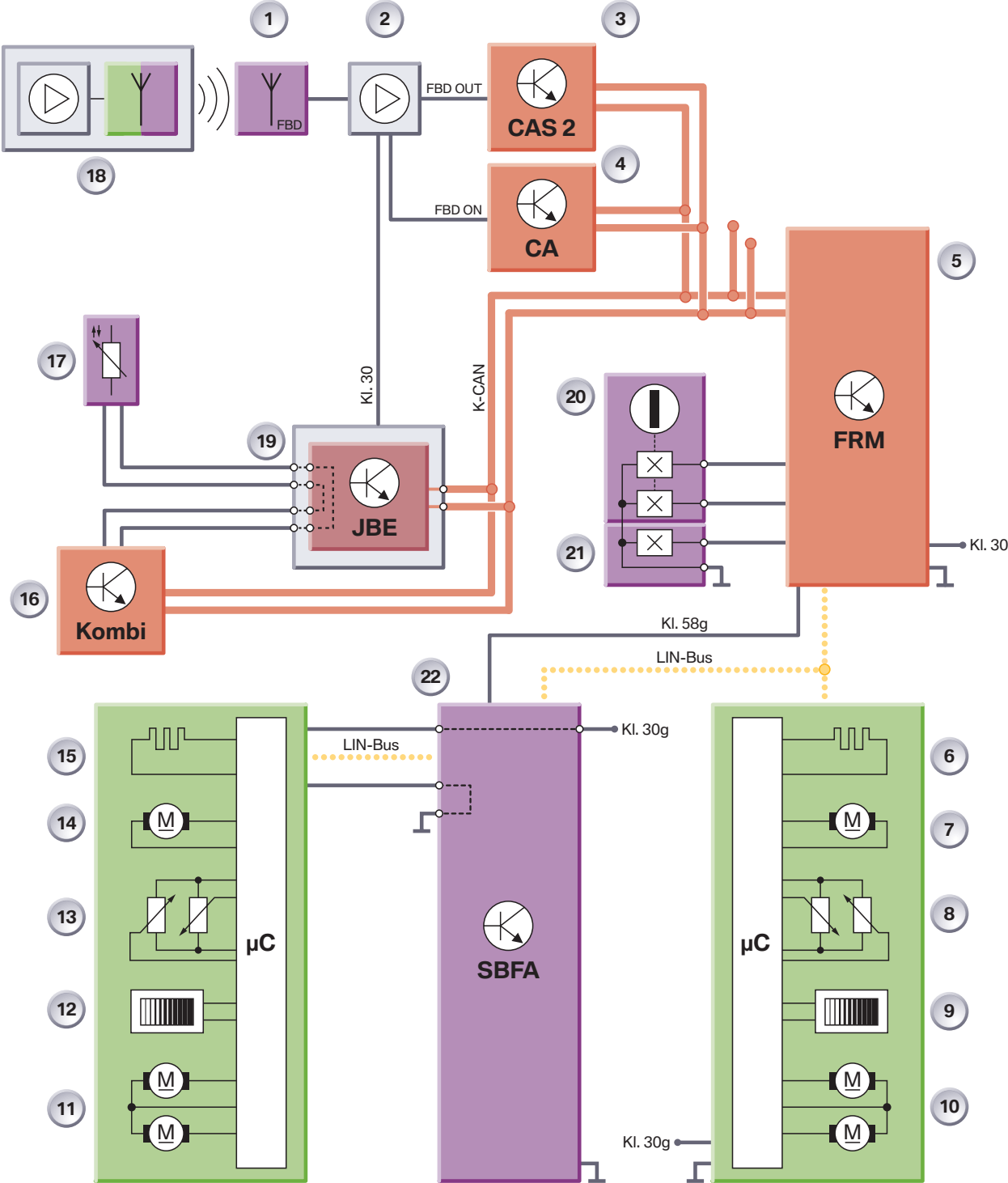
# Outside Mirror - Input/Output



## Legend for Outside Mirror - Input/Output

Index	Explanation	Index	Explanation
1	Rear window antenna	16	Instrument cluster
2	Remote control receiver	17	Outside temperature sensor
3	Car access system 2 CAS 2	18	Remote control
4	Comfort access CA	19	Junction Box Electronics Control Module (JBE)
5	Footwell module FRM	20	Lock cylinder, driver's door
6	Outside mirror heating, passenger's side	21	Door contact, driver's door
7	Motor for folding mirror function, passenger's side	22	Driver's door switch cluster SBFA
8	Memory, outside mirror potentiometer, passenger's side	LIN-Bus	Local interconnected network bus
9	Electrochromatic outside mirror, passenger's side	Kl. 30	Terminal 30
10	Actuator motor for passenger's side outside mirror	Kl. 30g	Terminal 30g
11	Actuator motor for driver's outside mirror	Kl. 58g	Terminal 58g
12	Electrochromatic outside mirror, driver's side	FBD	Remote control services
13	Memory, outside mirror potentiometer, driver's side	FBD ON	Remote control services ON
14	Motor for folding mirror function, driver's side	FBD OUT	Remote control services OUT
15	Outside mirror heating, driver's side		

# Outside Mirror - Circuit Diagram



## Legend for Outside Mirror - Circuit Diagram

Index	Explanation	Index	Explanation
1	Rear window antenna	16	Instrument cluster
2	Remote control receiver	17	Outside temperature sensor
3	Car access system 2 CAS 2	18	Remote control
4	Comfort access CA	19	Junction Box Electronics Control Module (JBE)
5	Footwell module FRM	20	Lock cylinder, driver's door
6	Outside mirror heating, passenger's side	21	Door contact, driver's door
7	Motor for folding mirror function, passenger's side	22	Driver's door switch cluster SBFA
8	Memory, outside mirror potentiometer, passenger's side	LIN-Bus	Local interconnected network bus
9	Electrochromatic outside mirror, passenger's side	Kl. 30	Terminal 30
10	Actuator motor for passenger's side outside mirror	Kl. 30g	Terminal 30g
11	Actuator motor for driver's outside mirror	Kl. 58g	Terminal 58g
12	Electrochromatic outside mirror, driver's side	FBD	Remote control services
13	Memory, outside mirror potentiometer, driver's side	FBD ON	Remote control services ON
14	Motor for folding mirror function, driver's side	FBD OUT	Remote control services OUT
15	Outside mirror heating, driver's side		

# Seats

## Seat Heating

### Seat Heating Module

The seat heating is operable as from terminal 15 ON. The junction box control unit determines what type of seat module is installed in the vehicle. It sends a corresponding query via the K-CAN for this purpose. Since the seat heating module is not connected to the K-CAN, only the driver's seat module with memory function can respond to the query. The junction box control unit must register a response within 200 ms. If the response fails, the junction box control unit undertakes control of the seat heating system.

On vehicles with a seat heating module, the junction box is responsible for converting the K-CAN telegram with switch information to a PWM signal for the seat heating module. The seat heating module activates the seat heating systems corresponding to the setting.

The seat heating function is available as from terminal 15 ON and activation of the seat heating module. The seat heating module is connected to terminal 30 for the load current.

After the seat heating button has been pressed, the center console switch cluster routes the request to the automatic climate control system. As a link element, it sends the requests via the K-CAN to the junction box control unit. In turn, the junction box control unit sends a pulse width-modulated signal to the seat control unit. The pulse width depends on the required heating output stage.

The control unit receives the PWM signal corresponding to the temperature setting for the seat heating module. The seat heating module regulates the seat heating to the temperature specified by the junction box control unit.

The seat heating module determines the temperature by means of an NTC resistor in the heating mat of the seat cushion.

### Seat Module, Driver's Side

The driver's seat module is connected to the K-CAN on vehicles with memory function. The driver's seat module evaluates the telegrams with the switch information and correspondingly controls the seat heating. The driver's seat module determines the set temperature by means of the NTC resistor in the heating mat of the seat cushion. A fault in the seat heating system results in a corresponding entry in the fault code memory of the driver's seat module.



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## Settings

### Seat

With the exception of the driver's seat module with memory function, the seat settings are implemented directly via the seat adjustment switches. Adjustment is possible as from terminal 30. The blocking detection function for the motors is located in the junction box control unit. For this purpose, the motor current is registered and motor blocking is detected above a defined current threshold.

#### **Driver's Seat Module with Memory Function**

The seat adjustment switches are also read directly in connection with the driver's seat module with memory function but in this case by the driver's seat module with memory function itself. The seat adjustment switches supply a defined voltage corresponding to the request. Based on these voltage values, the driver's seat module determines what motor it must activate. Activation takes place via the relay in the driver's seat module until the seat adjustment switch is released or the end of the adjustment range is reached.

The Hall sensors in the adjustment motors supply Hall pulses which are evaluated by the driver's seat module with memory function. The seat position is determined based on the Hall pulses. This function is used not only to detect the end stops but also to store the memory position of the driver's seat.

Blocking of a motor is detected by means of the current measurement function integrated in the driver's seat module. In this case, the relays are no longer actuated thus shutting down the motors. The memory setting for this motor is inhibited until the motor is no longer blocked.

#### **Lumbar Support**

The lumbar support setting supports the spinal column and provides a more relaxed seating position for driving. The lumbar support function was adopted from the E46 and adapted to the seat of the E90.

#### **Backrest Width**

The backrest width adjustment is available only in connection with the sports seat. The function is located in the electronic circuitry in the valve block for the backrest width adjustment. The width of the backrest can be adjusted as from terminal 30.

When the backrest width adjustment switch is pressed to reduce the width of the backrest, the electronic circuitry in the valve block receives a low signal and correspondingly control the pressure control valves.

At the same time, the pump motor is activated and fills the two backrest width cushions on the left and right in the backrest.

To widen the backrest width, the pressure control valves are activated and the backrest width cushions are emptied.

## Memory Function

The memory function for the driver's seat can be activated as from terminal R ON. Two memory positions and the current seat position can be stored. By pressing the memory button "M" followed by pressing button "1" or "2", the current position of the driver's seat is assigned to the pressed button. At the same time, the current position of the outside mirrors is also assigned to the pressed button. The information for storing the outside mirror position is sent by the driver's seat module via the K-CAN.

**Note: The memory position of the outside mirrors is stored in the Footwell Module.**

## Controls

### Backrest Width Adjustment Button

The backrest width button switches to ground. The button returns to its initial position after every time it is pressed. It is integrated in the side panel of the seat.



**Backrest width adjustment button**

### Lumbar Support Button, Seat Adjustment Switch, Memory Button

The lumbar support button is connected directly to the pump and the adjustment valves. The seat adjustment buttons and memory buttons are connected directly to the driver's seat module with memory function.



**Lumbar support button, seat adjustment switch and memory buttons**

Index	Description	Index	Description
1	Backrest width adjustment button	3	Seat adjustment switch
2	Lumbar support button	4	Memory button, driver's seat only

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## Control Units

### Center Console Switch Cluster

The switches for the seat heating are integrated in the center console switch cluster. They are designed as 3-stage switches.

The first switch stage switches on the seat heating with maximum heating power. The medium heating setting is activated after pressing the button a second time. The seat heating with the lowest heating output setting is switched on in the third switch stage.

The seat heating is switched off by pressing the button again or pressing it for longer than 1.2 s.

The center console switch cluster is connected by means of a ribbon cable to the air conditioning control unit (IHKA). The control unit makes the connection to the K-CAN.

### Junction Box Electronics Control Module (JBE)

The JBE features a control output each for the driver's and front passenger's seat heating. The signal sent by the JBE is pulse width modulated. The signal frequency is 25 Hz.

**Note: The JBE undertakes the control of the driver's seat heating only when no driver's seat module with memory function is installed.**

### Seat Heating Module

The seat heating module evaluates the signal from the junction box control unit. The seat heating module is connected by means of three connectors. One connector establishes the connection to the vehicle. The other two connectors are responsible for connecting the seat heating.

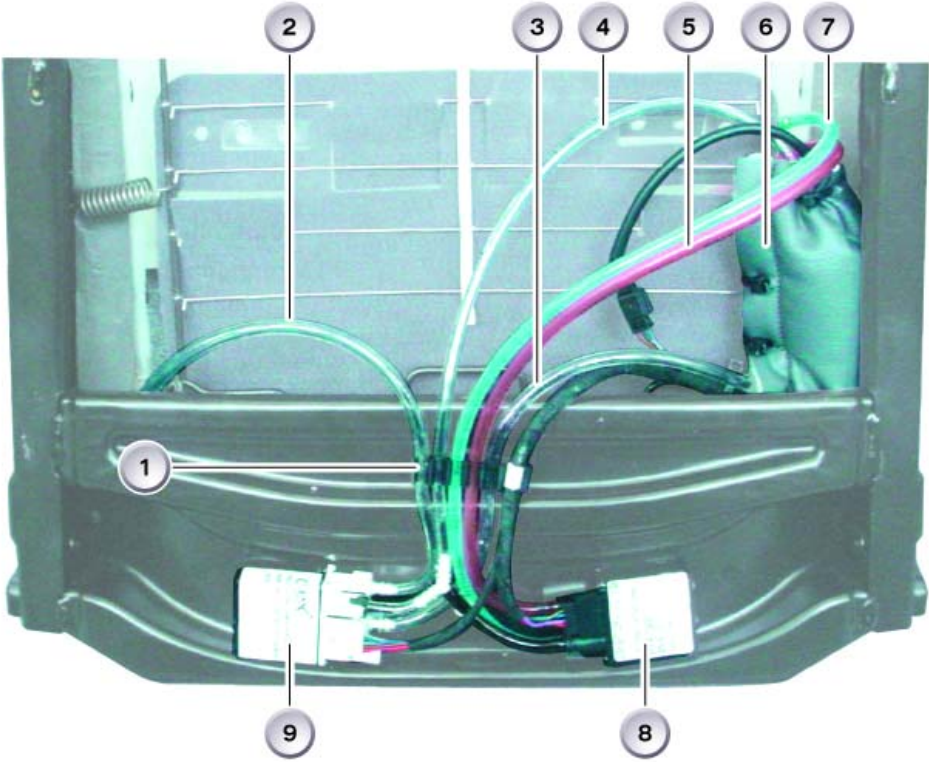
### Driver's Seat Module with Memory Function

The driver's seat module is installed when the seat is equipped with electrical adjustment and a memory function. The seat module therefore receives the information via the K-CAN for controlling the seat heating. The seat module also evaluates the memory buttons and the seat adjustment switches.

The requests from the memory buttons for the outside mirrors are made available via the K-CAN. The seat memory setting is stored in the seat module.

The requests from the seat adjustment switches are executed directly by the seat module.

# Seat



## Seat Components

Index	Description	Index	Description
1	Cable holder	6	Pump
2	Air hose, backrest width adjustment, left	7	Air hose, lumbar support adjustment, upper lumbar support cushion
3	Air hose, backrest width adjustment, right	8	Valve block, lumbar support adjustment
4	Air hose, pump	9	Valve block, backrest width adjustment
5	Air hose, lumbar support adjustment, lower lumbar support cushion		

## Lumbar support and backrest width adjustment



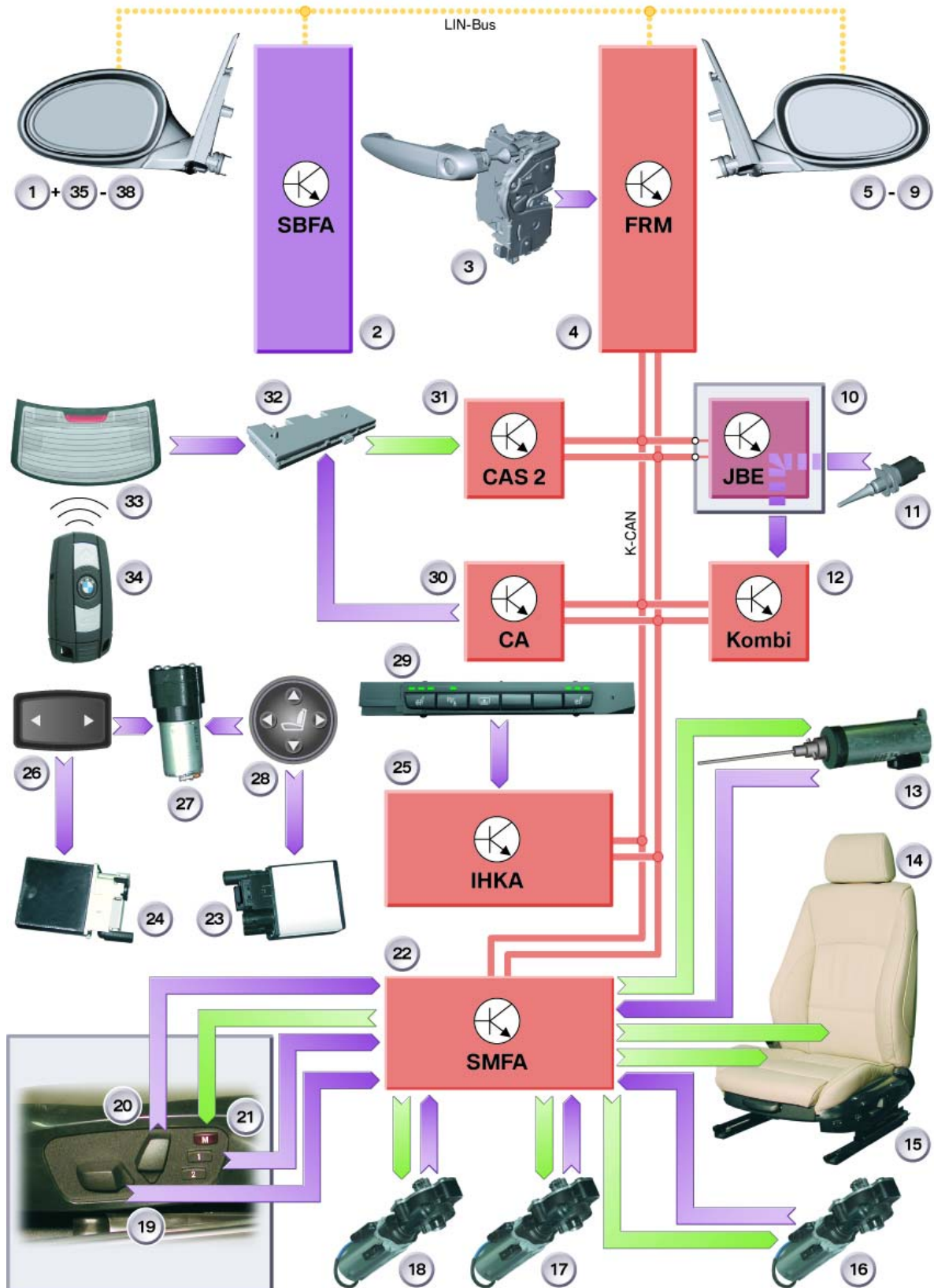
Lumbar support setting, backrest width setting, maximum (1)/minimum (2)

Index	Description	Index	Description
1	Increase lumbar support and reduce backrest width	2	Reduce lumbar support and increase backrest width

### Seat heating

The seat heating consists of a heating mat in the backrest and in the seat cushion. The heating mats form a single-circuit system. An NTC resistor is located in the heating mat of the seat cushion to control the temperature of the seat heating system. The seat heating is operable as from terminal 15 ON.

# Electrically-adjustable Sports Seat - Input/Output

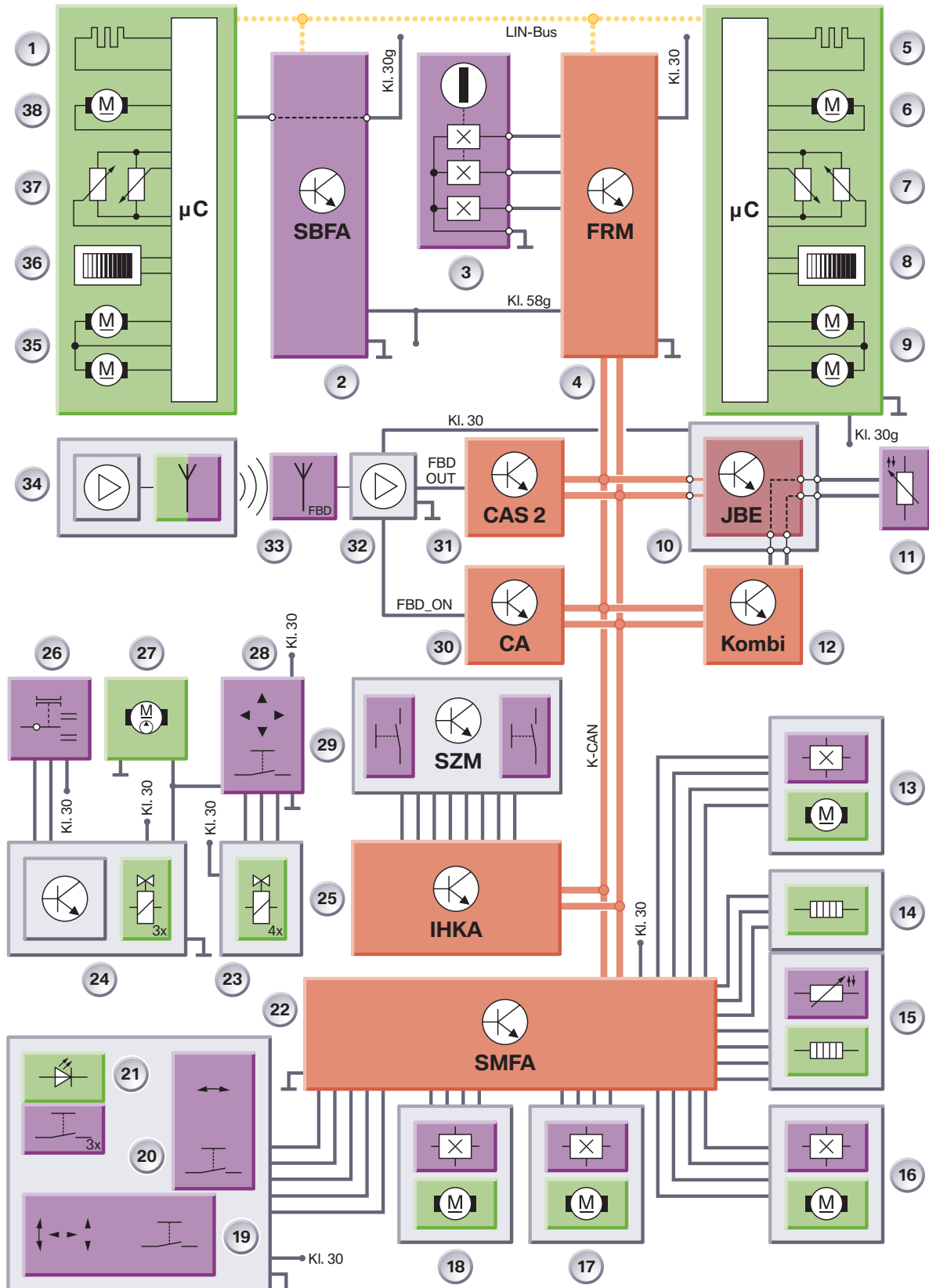


## Legend for Electrically-adjustable Sports Seat

Index	Description	Index	Description
1	Outside mirror heating, driver's side	25	Integrated heating and air conditioning system
2	Driver's door switch cluster	26	Backrest width adjustment button
3	Driver's door barrel lock	27	Motor for lumbar support and backrest width adjustment
4	Footwell module FRM	28	Lumbar support button
5	Outside mirror heating, passenger's side	29	Center console switch cluster
6	Motor for fold-in outside mirror, passenger's side	30	Comfort access CA
7	Potentiometer for outside mirror position memory, passenger's side	31	Car access system 2 CAS 2
8	Electrochromatic outside mirror, passenger's side	32	Remote control receiver
9	Outside mirror adjustment motor, side	33	Rear window antenna
10	Junction Box Electronics Control Module (JBE)	34	Identification transmitter
11	Outside temperature sensor	35	Outside mirror adjustment motor, driver's side
12	Instrument cluster	36	Electrochromatic outside mirror, driver's side
13	Motor for seat height adjustment	37	Potentiometer for outside mirror position memory, driver's side
14	Backrest heating	38	Motor for fold-in outside mirror, driver's side
15	Seat cushion heating	K-CAN	Body CAN
16	Motor for seat angle adjustment	LIN-Bus	LIN-Bus
17	Motor for seat backrest angle adjustment	KI.15	Terminal 15
18	Motor for seat longitudinal adjustment	KI. 30	Terminal 30
19	Switch for seat settings	KI. 30g	Terminal 30g
20	Backrest adjustment switch	KI. 58g	Terminal 58g
21	Memory buttons	FBD	Remote control services
22	Driver's seat module (SMFA)	FBD ON	Remote control services ON
23	Pressure control valves for lumbar support adjustment	FBD OUT	Remote control services OUT
24	Pressure control valves for backrest width adjustment		



# Electrically-adjustable Drivers Sports Seat w/Memory Function

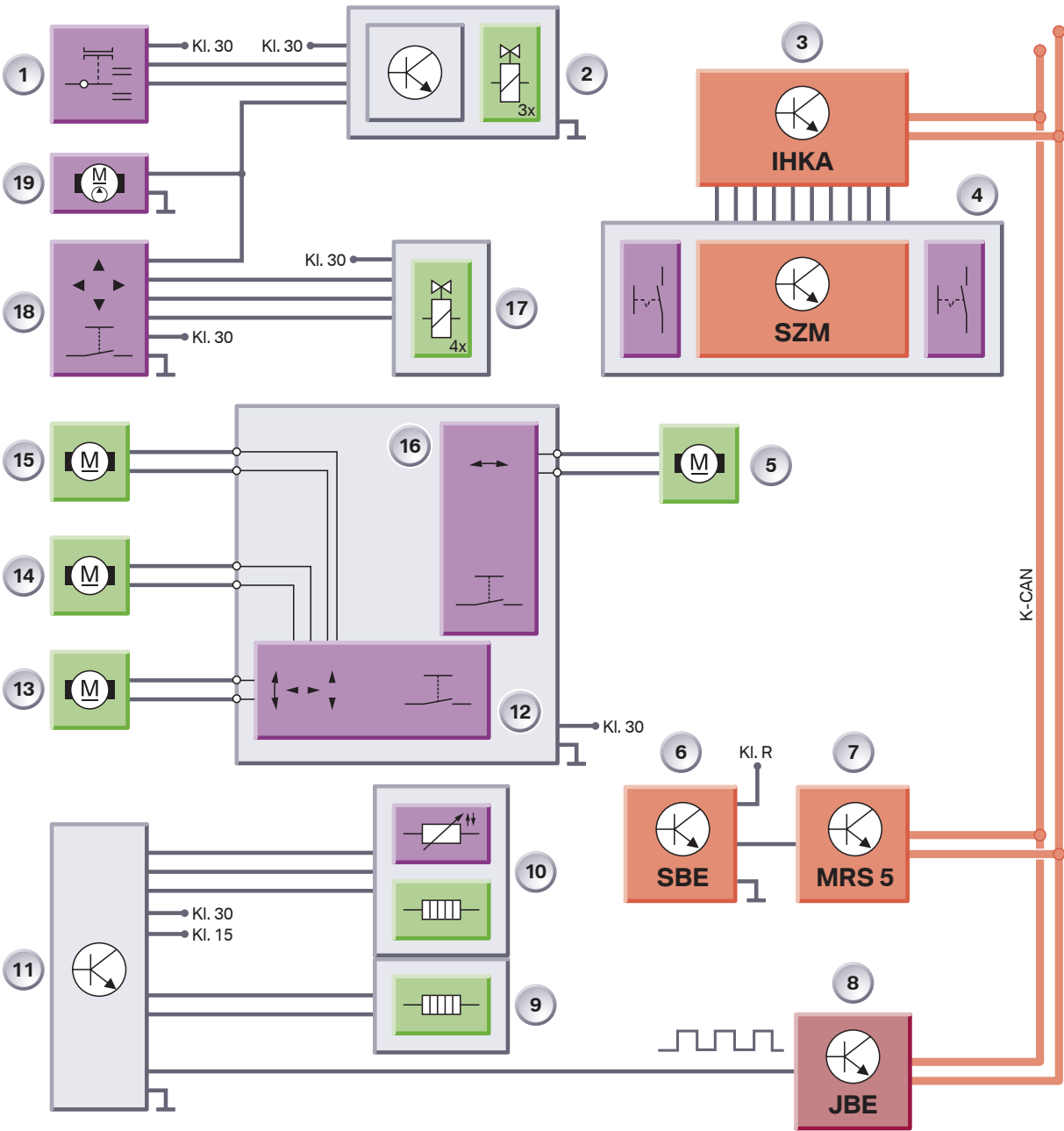




## Legend for Electrically-adjustable Sports Seat

Index	Description	Index	Description
1	Outside mirror heating, driver's side	25	Integrated heating and air conditioning system
2	Driver's door switch cluster	26	Backrest width adjustment button
3	Driver's door barrel lock	27	Motor for lumbar support and backrest width adjustment
4	Footwell module FRM	28	Lumbar support button
5	Outside mirror heating, passenger's side	29	Center console switch cluster
6	Motor for fold-in outside mirror, passenger's side	30	Comfort access CA
7	Potentiometer for outside mirror position memory, passenger's side	31	Car access system 2 CAS 2
8	Electrochromatic outside mirror, passenger's side	32	Remote control receiver
9	Outside mirror adjustment motor, side	33	Rear window antenna
10	Junction Box Electronics Control Module (JBE)	34	Identification transmitter
11	Outside temperature sensor	35	Outside mirror adjustment motor, driver's side
12	Instrument cluster	36	Electrochromatic outside mirror, driver's side
13	Motor for seat height adjustment	37	Potentiometer for outside mirror position memory, driver's side
14	Backrest heating	38	Motor for fold-in outside mirror, driver's side
15	Seat cushion heating	K-CAN	Body CAN
16	Motor for seat angle adjustment	LIN-Bus	LIN-Bus
17	Motor for seat backrest angle adjustment	Kl.15	Terminal 15
18	Motor for seat longitudinal adjustment	Kl. 30	Terminal 30
19	Switch for seat settings	Kl. 30g	Terminal 30g
20	Backrest adjustment switch	Kl. 58g	Terminal 58g
21	Memory buttons	FBD	Remote control services
22	Driver's seat module (SMFA)	FBD ON	Remote control services ON
23	Pressure control valves for lumbar support adjustment	FBD OUT	Remote control services OUT
24	Pressure control valves for backrest width adjustment		

# Electrically-adjustable Drivers Sports Seat with no Memory



### Legend for Electrically-adjustable Drivers Sports Seat with no Memory

Index	Description	Index	Description
1	Backrest width adjustment button	13	Motor for seat angle adjustment SNV
2	Pressure control valves for backrest width adjustment	14	Motor for seat forward/backward adjustment SLV
3	Integrated heating and air conditioning system	15	Motor for seat height adjustment SHV
4	Center console switch cluster SZM with switch for seat heating	16	Motor for seat backrest angle adjustment LNV
5	Motor for seat backrest angle adjustment LNV	17	Pressure control valves for lumbar support adjustment
6	Seat occupancy detection, passenger's seat	18	Lumbar support button
7	Multiple restraint system 5 MRS 5	19	Pump for lumbar support and backrest width adjustment
8	Junction Box Electronics Control Module (JBE)	K-CAN	Body CAN
9	Backrest heating	KI. 30	Terminal 30
10	Seat cushion heating	KI.15	Terminal 15
11	Seat heating module	K-CAN	Body CAN
12	Seat adjustment button		

# Rear Sun Shade

## Functions

### Overview

The electrically operated roller sun blind features the following possible functions:

- Rear sun shade up and down
  - End position recognition
  - Relieving tension in rear sun shade
  - Motor protection
- Sleep mode
- Child lock
- Undervoltage

### Rear Sun Shade Up and Down

#### ■ Switch-on Conditions

The rear sun shade can be operated as of "Terminal R ON" and is coupled to the enable for the Power Windows. The Car Access System 2 issues the enable via the K-CAN.

The rear sun shade can be operated only when the power window function is enabled. The enable is also dependent on the country specific version and the status of the door contact.

#### ■ Operation

The rear sun shade can be raised and lowered with the button in the center console. The control button needs only to be pressed briefly. The rear sun shade will move in the opposite direction if the control button is pressed again.

#### ■ Signal Path

The SZM evaluates the signal from the control button and forwards it to the IHKA. The IHKA transfers the signal to the K-CAN and sends it to the junction box control unit. In turn, the junction box control unit activates the motor for the rear sun shade.

#### ■ End Position Recognition

The motor blocks and the movement of the rear sun shade stops in the end position. The junction box control unit recognizes the end position by the increasing current and switches off the motor.

#### ■ Relieving Tension in Rear Sun Shade

The rear sun shade is briefly reversed for approx. 20 ms in order to relieve the tension as fast as possible after blocking. This function protects the drive unit and mechanism of the rear sun shade.

#### ■ Motor Protection

To protect the motor, the maximum activation time of the motor is limited to approx. 10 s.

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## **Anti-trapping Protection**

The rear sun shade has no electronic anti-trapping function. The mechanism and drive units are designed such as to rule out any danger for the occupants posed by excessively high forces.

## **Child Safety Lock**

The child safety lock is enabled or disabled by means of a button located in the driver's door switch cluster. It is not possible to operate the electric rear sun shade when the child safety lock is enabled.

Current operation of the rear sun shade is not interrupted when the child safety lock is enabled.

## **Undervoltage**

Operation of the rear sun shade is disabled if the system voltage drops below 9.0 V. Operation of the rear sun shade is enabled again with a system voltage higher than 9.5 V.

Current operation of the rear sun shade is not interrupted by the undervoltage protection facility but rather the procedure is completed.

## **Behavior after Reset**

After a reset it is assumed that the rear sun shade is in the up position. On receiving the first request, an attempt is made to move the rear sun shade downward. The direction is reversed once if a blocking state is detected directly after activation.

## **Sleep Mode**

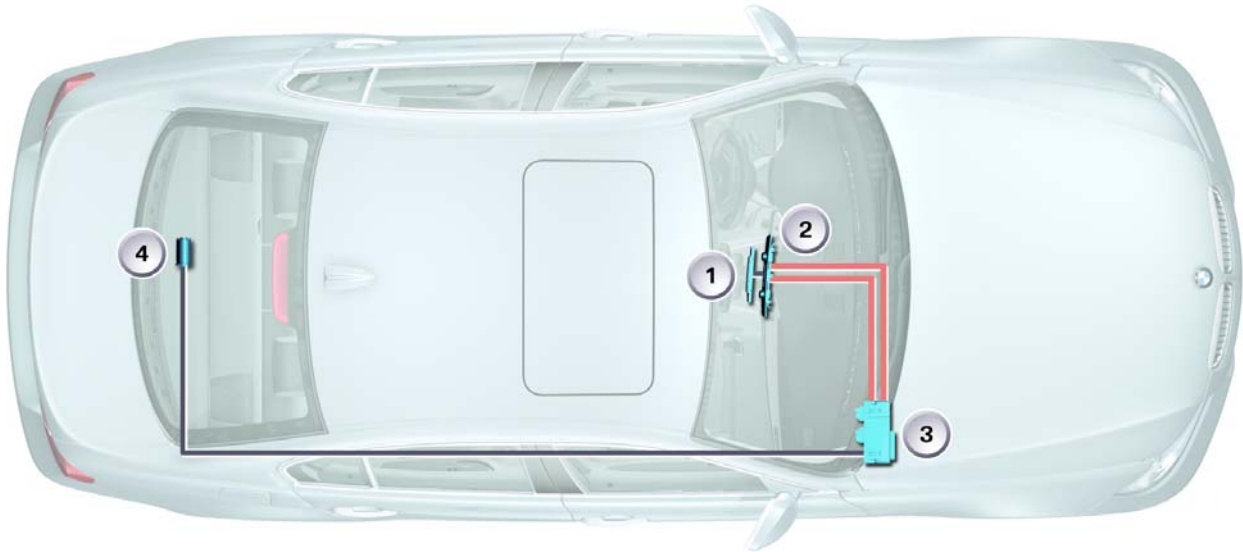
The current position of the rear sun shade is stored in the JBE as soon as the vehicle assumes sleep mode.

## **System Components**

The following components are involved in operation of the rear sun shade:

- Button for rear sun shade
- Control units
  - Integrated automatic climate control
  - Junction Box Electronics Control Module
- Rear window sun shade motor.

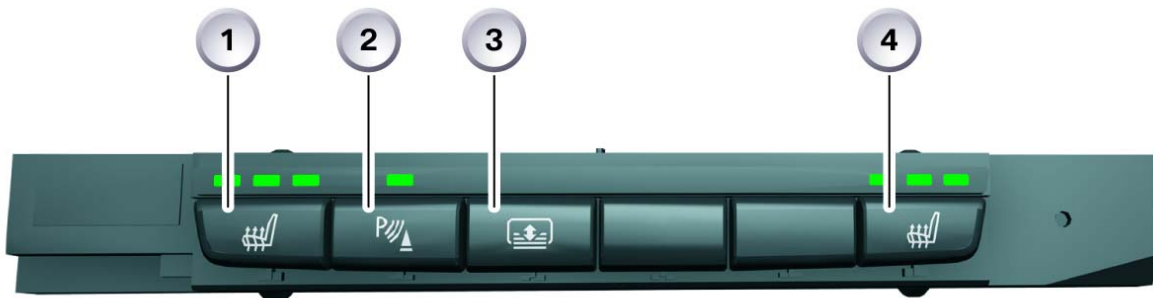
## Rear Sun Shade System Components



Index	Description	Index	Description
1	Center console switch center SZM	3	Junction Box Electronic Control Module (JBE)
2	Integrated heating and air conditioning system IHKA	4	Motor, rear sun shade

## Control Button

The control button is included in the center console switch cluster and switches to ground.



Center console switch cluster with control button for rear sun shade

Index	Description	Index	Description
1	Control button for driver's seat heating	3	Button for rear sun shade
2	Control button for park distance control	4	Control button for passenger's seat heating

## Control Units

### Integrated automatic heating and air conditioning control/automatic climate control

The integrated automatic heating and air conditioning control/automatic climate control receives the signal from the control button and transfers it to the K-CAN.

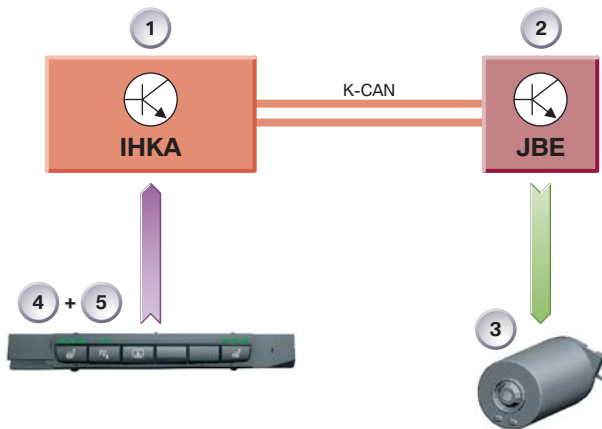
### Junction Box Electronics Control Module

The Junction Box Electronics Control Unit contains the motor drive function for the electric rear sun shade.

### Rear Sun Shade Motor

The motor is designed as a DC motor and moves the two lifting arms of the rear sun shade in the UP or DOWN direction.

### Rear Sun Shade - Input/Output



Index	Explanation
1	Integrated heating and air conditioning system IHKA
2	Junction Box Electronics Control Module (JBE)
3	Motor, rear sun shade
4	Center console switch center SZM
5	Button for rear sun shade
K-CAN	Body CAN

### Rear Sun Shade - Circuit Diagram

